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Geographical Journal.

No. 4. OCTOBER, 1910. Vol. XXXVII.

THE LAND OF THE INCAS.*

By Sir CLEMENTS R. MARKHAM, K.C.B., F.R.S.

I PROPOSE to ask for the attention of the meeting while I refer to a map on which two of the officers of our Society have been at work for the last two years, and while I endeavour to describe the area which the map covers. It is a map of Southern Peru and part of the north of Bolivia, including the vast forest region to the eastward, most of which has quite recently been discovered and explored. The area covered by the map is the land of the Incas; and no country in the wide world possesses such a variety of climates, of geographical features, and of products.

The time had arrived for the construction of a map of this region, which will be the best for many years to come. Maps of Peru have been made at intervals for ages. The Incas, before the Spaniards came, made relief-maps of clay for administrative purposes, which answered their object admirably. In the sixteenth century the Spanish Government ordered all their local officers to submit detailed topographical reports on their districts which still exist, and have recently been published. Later there were official cosmographers at Lima; but they produced very poor maps.† The first map of the land of the Incas with any pretensions to being based on astronomical observations was that of Mr. Pentland, including Cuzco and Lake Titicaca, an account of which will be found in one of the earliest volumes of our *Journal*. It was published by the Admiralty. In more modern times appeared the atlas of Paz Soldan, and later the atlas of that indefatigable traveller and scientific explorer, Antonio Raimondi. But since then

* Read at the Royal Geographical Society, May 9, 1910, Map, p. 512.

† Lozano, Agustin de Mendoza y Arquedas, and towards the end of the eighteenth century, Andres Baleato, whose map was published in 1792. Father Fritz produced his map of the Amazonian valley, with the localities of the numerous tribes, in 1707.

numerous discoveries have been made to the eastward of the Andes, and the time has come for the construction of the Society's present map.

Our map is divided into four sections, two covering the mountainous region of the Andes (I. the Cuzco division to north-west, and II. the Titicaca division to south-west). The eastern divisions III. and IV. cover the vast forests of the part of the Amazonian basin drained by the great rivers flowing from the eastern slopes of this part of the Andes.

We turn first to the north-western division, and to enter it we must cross the formidable Maritime Cordillera, not in a railway train, not even in the best time for travelling. By lovers of grand and imposing scenery the Cordillera should be crossed in the worst time, in the height of the rainy season. The coast of Peru presents a study of extraordinary geographical interest, but there is no time to dwell upon that now. We leave it by one of the passes, and at first the scenery is grand, but desolate and forbidding.

As soon, however, as the zone of rains is reached there is a complete change. We ascend into the lofty region known as the Puna. The declivitous mountain-slopes are covered with tufts of coarse grass. On one hand there is a precipice, the dark side of which is lost in clouds far below, and the roar of an unseen torrent is distinctly heard. Still ascending, we come to the heights frequented by vicuñas, graceful, beautiful animals, of a light-fawn colour, with fleeces like silk, long slender necks, and small camel-like heads. There, too, are the little viscachas, with short fore-legs and bushy tails, and the loudly screaming lecco-lecco, a species of plover. The snow lies on the backs of the vicuñas. It is the Riti-suyu, or region of snow. Here, on the water-parting, the sky is charged with mist, and the snow is falling heavily, while the roaring waters make a deafening noise. Some are flowing to the Pacific, others are rushing down to where—

> "Swelled by a thousand streams,
> Impetuous hurled from all the roaring Andes,
> Huge descends the mighty Orellana."

But night approaches as we leave the Pacific watershed, and come upon the sources of the Amazonian streams. Descending we enter a narrow defile with perpendicular cliffs on either side. Here an overhanging rock is used as a cave to shelter travellers. But not in the rainy season; for it is filled with snow, and water pours from icicles on the roof. The rainy season traveller must pass the night standing, with his head on the mule-saddle. Far below thunder peals loudly, with flashes of forked lightning. As morning dawns the snow ceases, the heavy mists gather themselves together and roll down the ravines, A precipitous descent over slippery rocks leads down to grassy plains and rapid rivers, with glorious views of the snowy mountains. Here are gorges with precipitous sides, and torrents dashing over masses of

rock several hundreds of feet below. A few poles are thrown across to form a bridge. Beautiful cascades course down the sides of the precipices and in most of the passes there are alpine lakes contrasting their brilliant azure with the snowy slopes.

All this is a splendid welcome to the land of the Incas. That region extends from the water-parting of the Maritime Cordillera to that of the Eastern Andes, and from the gorges through which the rivers force their way into the Amazonian plain to the knot of Vilcañota where the two Andean chains unite. It is a well-defined region, much of it very little known, and never described by a trained explorer.

Three important rivers traverse it from south to north—the Pampas, a tributary of the Apurimac rising in the Maritime Cordillera; the great river Apurimac itself, also rising in the Maritime Cordillera, and forcing its way through the Andes to join the Ucayali; and the Vilcamayu, flowing along the western skirts of the Eastern Andes to unite with the Apurimac. The gorges where the waters are forced into a narrow space and form rapids as they cut through the Andes are called Puncu-cuna, or gates. The Pampas and Apurimac flow through profound ravines, while the Vilcamayu waters a lovely valley.

This section of Peru, comprising the land of the Incas, is bounded by the Maritime Cordillera and the Eastern Andes on the west and east, forming impenetrable walls. No river forces its way through them. But on the northern side the chain is broken where its direction is easterly with southing. Here there are short mountain ranges separated by the action of rivers, such as the heights of Cuntur-cunca, at the foot of which Peruvian independence was gained; the lofty spurs of Pincos and Argama; the mountain mass of Vilcapampa, between the Apurimac and the Vilcamayu; the lofty range bounding the Vilcamayu valley to the east, and the heights between the Paucar tambo and Yanatilde rivers.

It is worthy of special consideration that this turn in the direction of the Cordilleras of the Andes, where they are broken through by the rivers, coincides exactly with the change in the direction of the coast-line of Peru, which also changes from a meridional line to a south-easterly direction for 520 miles, and then again resumes its north and south line. It seems possible that this coincidence between the curve of the coast-line and of the Andes may point to the upheaval of the mountains subsequent to the formation of the existing shape of the western coast of South America. Here there would be more strain on the mountain masses owing to the change in direction, enabling the rivers to take advantage of weak spots which are not to be found in the meridional chains. So we find the principal rivers of the Land of the Incas flowing north, at the bottoms of ravines so deep that the lowest parts are covered with a tropical flora, while the summits are in a temperate climate. To cross the Apurimac after a long zigzag

descent, there is a rope-bridge 145 feet long and 118 feet above the rapid flood beneath. A similar rope-bridge spans the Pampas river.

The country between these rivers is a region of great beauty, and of wonderful variety of climates and products. In the lower valleys there are sugar estates. The beautiful and very extensive vale of Andahuaylas, and others, are suited for corn cultivation. Lofty spurs from the Cordillera rise up, sometimes reaching the snow level. At Abancay and other places the products of every clime may be seen on one mountain-side. On the river banks are fields of sugar-cane; then fruit-trees and banana groves; then terraced fields of maize; then barley, potatoes, and vegetables; above that, steep pastures where the llamas can just be made out like specks; above all, rocky heights ending in peaks.

In some places there are large swampy plains, at great elevations, covered with coarse grass and reeds. There is one such plain just before the descent commences to the city of Cuzco, called the Pampa de Surite.* It is a splendid battlefield, and the fate of Peru has twice been decided upon it. Hills on either side rise from the plain, with the small towns of Surite and Anta on their slopes. There is a causeway 3 leagues long, and raised several feet above the swampy ground, and in passing along it there are often fine atmospheric effects. A mass of dark clouds comes rolling over the hills from the south-east, the rest of the sky a dark blue. Graceful egrets leave their search for worms, and, screaming shrilly, whirl in wayward circles over the plain. Flocks of llamas, scattered in various directions, run for protection to a common centre and collect in round masses. Then the clouds burst out in loud peals of thunder, the lightning flashes forth, and the rain comes down in heavy drops while, all the time, the sun is shining brightly in the west. After about half an hour the storm passes on, leaving behind it a serene afternoon.

From the plain of Surite there is a descent of a few leagues to the city of Cuzco, the Rome of the New World, the central point of the land of the Incas, whence all roads diverged.

Cuzco is within the basin of the Vilcamayu river, its two torrents uniting below the temple of the Sun and flowing into it. The prehistoric fortress crowns the hill of Sacsahuaman, and the unrivalled masonry of the city itself, its position and its plan, are an eternal monument to Inca Pachacuti, the greatest man that the red race ever produced. But we cannot here dwell on the glories of Cuzco. We must pass at once from the sacred city to the sacred river.

The Vilcamayu rises under the peak of Vilcañota, that snowy pyramid which is visible from Cuzco. It means the "sacred source." The earliest recollection of the Inca Garcilasso de la Vega, the well-

* Also called Yahuar Pampa in the time of the Incas, and Xaquixaguana or Sacsahuana later.

FORTRESS OF CUZCO.

TEMPLE OF THE SUN, CUZCO.
(*F. W. Markham, photo.*)

LAKE TITICACA.
(Major Fawcett, photo.)

ON THE UPPER AQUIRY.
(Major Fawcett, photo.)

known commentator, was the sight of this snowy peak piercing the blue sky, from the balcony of his father's house. The Vilcamayu flows northwards down its valley, which increases in beauty as it descends, until it reaches the tropical forests, and unites with the Apurimac to form the mighty Ucayali. There is a charm about this lovely vale of Vilcamayu * which places it among the few paradises of this earth. The terraces full of ripening corn, arranged in patterns up the mountain-sides, the rapid river, the groves of fruit-trees, the singing birds, above all, the glories of Ollantaytampu, and the mountains rising above the snow-line and shooting dazzling peaks into the blue sky, combine to form scenes of rare loveliness.

Eastward of the Vilcamayu valley is the secluded district of Laris and the headwaters of the Yanatilde, separated by another range from the valley of Paucartampu. The eastern Andes form one side of the latter valley, and on the other side descend abruptly to the tropical forests. The map of this north-western division has not been easy to construct. We have a fixed position at Cuzco, and some of Mr. Pentland's observations, besides a few good latitudes. Otherwise we have had to rely on Raimondi's maps, and on the postal distances by rail and road. For now there is a railroad crossing the knot of Vilcañota at Sta. Rosa and descending the valley to Cuzco.

The south-western division of the map comprises the inland basin of Lake Titicaca, without any outlet either to the Atlantic or to the Pacific. The part of the Maritime Cordillera which bounds its western side offers easier access than the part further north, though the pass of Rumíhuasi is 17,700 feet above the sea. At the base of the western side of the Cordillera the city of Arequipa is surrounded by an extensive and fertile plain, and thence the route passes over the Cordillera to Puno on the shores of the great lake. Now there is a railroad, fortunately for commerce and business, but not for the traveller, who sees and learns nothing cooped up in a train. At the northern side of the basin of Lake Titicaca the Maritime Cordillera and the eastern Andes are united at the knot of Vilcañota, whence the pass leads down into the valley of the Vilcamayu. The eastern side of the Titicaca basin is bounded by the mighty chain of the Andes, here culminating in two of the loftiest measured peaks of the New World. Illimani is 21,190 feet, and Illampu 18,715 feet above the level of the sea.

The peaks of Huascaran in northern Peru, and outside the limits of our map, have recently been measured, with the result that one is 22,187 and the other 21,812 feet above the sea-level.

A great plateau occupies the northern half of the Titicaca basin, called the Collao, which is by no means level, being intersected by

* Called also the valley of Yucay, after the Inca palace. The river is called the Urubamba on some maps, after a town on its banks, but the Vilcamayu is the proper name from source to mouth.

ranges of hill, the highest being the precipitous rock of Pucara, 1200 feet above the plain, once famous for its breed of falcons.

The lake of Titicaca occupies the southern half of the basin, 120 miles long by 47 broad, 145 fathoms deep, and 12,508 feet above the level of the sea. Its outlet is by the Desaguadero to the south, which flows down into swampy lakes beyond the limits of the map. The lake has been gradually receding for centuries, owing to the excess of evaporation.

This region of the Collao, at an elevation of nearly 13,000 feet, has a rigorous climate. There is plenty of coarse grass, *Stipa Ichu*, a bush supplying firewood, called Tola (*Baccharis incarum*), and only two kinds of trees, gnarled and scraggy, and about the size of an olive-tree, called Queñuar (*Polylepis racemosa*) and Quisuar (*Buddleia incana*). Potato crops are raised—the staple food of the people—and a chenopodium, called Quinua. But corn will not ripen, and the unripe barley is only used for mules and horses.

Some miles from the southern shores of Lake Titicaca, once actually on the shore, there are the ruins of a great city, now called Tiahuanacu. In the time of the Incas it was the same ruin as it is now, its origin and history absolutely unknown, and myths were invented to account for the numerous stone statues. The ruins show very advanced proficiency in the masonic art, and there are monoliths which have been conveyed from great distances. The size of these cut and carved stones is unequalled in any other part of the world except Egypt. There must necessarily have been a very large population, and an immense food-supply. The question how a region where corn will not ripen can have been selected as a site for a great city is a problem which seems well worthy of study.

The site is over 12,000 feet above the sea. Cuzco is at an elevation of 11,000 feet. If the Tiahuanacu city flourished when the Andes were still 1000 feet lower, the problem would be solved. The Cordilleras of the Andes, if the grandest and most important mountains in the world, from their vast extent and productiveness, are the most modern. The conclusion of Dr. Reiche is that they had no existence even in so late a geological period as the cretaceous, and there seems to be evidence that the upheaval has been comparatively rapid. Darwin tells us that, in the neighbourhood of Valparaiso there has been a recent rise of 1200 feet. He also found remains, consisting of maize cobs and cotton twine, on the summit of the island of San Lorenzo, proving that the land has risen 80 feet within a time when human inhabitants were cultivating the land. This calls to mind the Huarochiri myth which declares that—

"When Viracocha was here our land was Yunca."

That is to say, that their tradition tells them that, in the golden age, the Huarochiri hills, at no great distance from Darwin's point of observation at San Lorenzo, were formerly valleys like those on the coast called Yunca.

Again, there are numerous skeletons of gigantic ant-eaters in the deserts of Tarapaca. I have presented two to the British Museum. No forests to support them could have existed in Tarapaca, while the Andes were at anything like their present height. These and other interesting geographical problems invite further study and exploration in the Titicaca region. Several lofty peaks are still neither ascended nor measured.

The construction of this division of our map called for no small amount of skill and research. There are fixed positions at Arequipa and also at La Paz, and there are Mr. Pentland's observations; Sir Martin Conway's triangulation of the Illimani and Sorata region, a valuable French survey of Lake Titicaca itself, and a Chilian survey of the northern part of Tarapaca, have been of great assistance, as well as the survey work of the railroads. The survey work of Mr. Minchin has also been useful.

The two eastern divisions of the map include the vast extent of forest-covered area, and the courses of the great rivers to the eastward of the Andes, which is generally known as the Montaña. It is here that the most important discoveries have been made in recent years, including the previously unknown courses of great rivers, and millions of acres of land yielding valuable products. On two occasions, when I was in Peru many years ago, I explored rather beyond the limit of what was then known, down the courses of four rivers, two of them of the first importance, the Yanatilde, Paucartambo, Tono, and Tambopata. Now, at length, the whole of their courses has been discovered.

Among the most enchanting regions of Peru are the spurs sloping down from the Andes to the dense forests of the Montaña. From the heights above Paucartambo the descent is rapid, the spurs do not extend far, and the scenery is more magnificent than further south. In Caravaya, the approach to the forests down these spurs is more gradual, and the surroundings more charming. The climate is delightful. The grassy uplands, called Pajonales, are sprinkled over with beautiful flowering shrubs. Here is the Panti-panti (*Lasiandra Fontanesiana*), a melastome covered with purple flowers. Here are the incense trees (*Clusia sp.*). Here, above all, is the shrub chinchona,* Weddell's *Chinchona Calisaya* (var. *β Josephiana*), with its panicles of lovely and fragrant flowers, and its glossy leaves with crimson veins. The highest claim of the Andes to pre-eminence as a mountain range is that they are the sole original homes of trees yielding quinine, and of the coca plant yielding cocaine. As the chinchona tree is the most beautiful tree in the forests, so the crested Tunqui, which feeds on its seeds, is the most beautiful bird.

On these uplands there are magnificent views towards the forests,

* Not Cinchona, a frequent and very unsightly mis-spelling. The genus was named after the Countess of Chinchon.

while a noise of many waters comes from the western mountains. Waterfalls stream down in every direction; some, in a white sheet of continuous foam for hundreds of feet, finally seem to plunge into beds of flowers and ferns; some, higher up, forming a glittering pillar of water, coming from between two peaks, and falling into fleecy clouds below.

A long descent at last brings us down to the tropical forests of the Amazonian basin, stretching away for hundreds of miles. Here the only highways are the great rivers, quite recently discovered. To cut a way through the forest the *machete* or wood knife must be used at every step. The trees crane up to such a height, seeking sunshine, that it is hardly possible to make out their leaves and flowers. In mid-air there is a tangle of *lianas*, and below dense masses of vegetation, here and there broken by a fallen tree. This is the region of the best kind of india rubber, while the upper courses of the rivers are charged with gold, which has been famous for its abundant yield since the days of the Incas. The Caravaya mines and washings will, in the near future, be one of the principal sources of gold supply.

The correct delineation of the courses of rivers on the eastern division of our map represents much heroic self-denial and devotion to duty, results attained in defiance of danger and disease, and by the sacrifice of precious lives.

The work in the northern part of the north-east division includes the course of the Aquiry, or Acre, a river which does not rise in the Andes, but further east in the forest country. First discovered by our gold medallist, Mr. Chandless, during his memorable survey of the river Purus, it has recently been surveyed by Major Fawcett for the Bolivian Government, so that perfect reliance may be placed on its correct delineation with its tributaries.

Next comes the course of the great river Amaru-Mayu, or Madre de Dios, the discovery of which, and of its tributaries, has entailed much heroic devotion and suffering. There was an interesting campaign in the forests through which its headwaters flow, conducted by the Incas in the fifteenth century. There also the Spaniards established several coca farms; but warfare with the wild Chuncho Indians was incessant. Our gallant old associate, General Miller, was the first Englishman to penetrate among the Huachipayri Chunchos, and there is an account of his journey in one of the earliest volumes of our *Journal*. When I made a journey down the course of the Tono to the Madre de Dios, eighteen years afterwards, I found that the Chuncho Indians had encroached to such an extent that there were only two coca estates left in the whole of the Montaña of Paucartambo. An abandoned estate returns to forest again almost within the year.

In my time Father Bovo de Revello, a Piedmontese, was tackling the problem of the Madre de Dios. I made a journey with him, and to

CAMP ON THE RIGHT BANK OF RIO QUIPANUASI.
(*Don C. Cipriani, photo.*)

CHILUANIMAYO, NEAR INAMBARI.
(*F. W. Markham, photo.*)

him is due the discovery of the Piñi-Piñi tributary of the great river. He lost his companion, a young priest, who was found in their small clearing riddled with Chuncho arrows. The good Father died at his post, a great man though unknown to fame. The Madre de Dios was then supposed to be the Purus. But in 1861 an enterprising young native of Cuzco, named Maldonado, proved that the Madre de Dios united with the Beni. He gave his life to prove it. He descended the whole course of the river with a few companions, but was drowned in a rapid, thus sacrificing his life to make this great discovery.

The most northern important tributary of the Madre de Dios is the river Manu, which has now been explored, and the position of its mouth fixed. A very enterprising rubber collector named Fitzgerald has discovered an easy portage from the Ucayali to the Madre de Dios by this river Manu, which has been named after him the Isthmus of Fitzcarrald.

There still remained the exploration of the more southern tributaries of the Madre de Dios, namely the Cosñi-Pata, and Huasampilla, or Pilcopata. I constantly urged the desirability of completing this piece of exploring work, and have cause to mourn over the tragic end of one of the attempts. The Pilcopata was first visited by Herman Gohring in 1873.

In 1905 Colonel Heraclio Fernandez set out on a similar enterprise, with his young son Alcides, and two gallant young explorers named Mariano and Agustin Novoa y Chacon. The mother, Doña Victoria Novoa, was a very old and very dear friend of my own, born and bred in Cuzco, the sacred city of the Incas. All went well at first, and after penetrating for days through dense forest a depôt of provisions was left in a small patch of sugar-cane. This was in the end of May. The party then separated. The young Novoas, with most of the men, took a direct line. Colonel Fernandez and his son, with an attendant named Julio Bravo, undertook to follow the course of the Pilcopata. They lost their way in the dense forest. Provisions ran out. They could hear the river far below them, but could not reach it owing to the precipices being perpendicular. They fought their way on along a ridge until June 8, living on the water they squeezed from the moss. At length a way down was found. By this time young Alcides, who was only fourteen, was too weak to walk. The other two carried him down to the river bank. He died on the 14th. The broken-hearted father did not long survive him. Julio Bravo found him dead next morning, with his head in the river. Julio found his way back, living on the leaves of a plant called Huaccatay (I think it is a Tagetes), until he reached a clearing where he got some green maize. The colonel had kept a journal almost to the last. The other explorers suffered equal privations. Most of them died of fever and starvation. The brave lads, Mariano and Agustin Novoa, came back indeed, but stricken by

fever, to which they both succumbed. The whole story is very sad. I tell it that we may remember that our geographical knowledge can only be acquired through the fortitude and self-denial of those who sacrifice their health and their lives to collect it for us.

Don Jorge von Hassel, an engineer, and Lieut. Oliveira submitted a report on the Pilcopata and its headwaters in 1905.

The work of exploration of the next river, the Marcapata, also exacted the life of a pioneer, Mr. Backhouse, but that was many years ago.

The rivers of Caravaya, the Huari-Huari, or San Juan Del Oro, the Ollachea, or San Gavan, and others which, with the Marcapata, combine to form the Inambari, have been known for a long time, because the Incas, the Spaniards, and modern Companies have derived great store of gold from that province for centuries. But any approach to the correct delineation of the courses of these rivers is the work of quite recent times. The officers of the Peruvian Fluvial Commission, Villalta, Cipriani, Stiglich, and others, have done excellent work, and our Society has conferred one of its awards on Don Juan S. Villalta. Accomplished travellers, such as Baron Erland Nordenskiöld, whose investigations bore upon the anthropology of the region, and our accomplished Antarctic associate, Louis Bernacchi, have given us interesting accounts of Caravaya.

The headwaters of the river Tambopata were explored by me, in my search for chinchona plants, and afterwards by Raimondi. A few years ago the officers of the Fluvial Commission, Villalta and Stiglich, explored the whole course of this important river. The port where it becomes navigable was named after me, and the port at its mouth has received the name of Maldonado, after the devoted explorer.

The lower waters of the Madre de Dios have been explored and mapped by the Bolivians, who have done a great amount of excellent work. Colonel Pando ascended the stream as far as the mouth of the Tambopata. Fray Nicolas Armentia, Dr. Ramon Paz and others have been equally enterprising, and we owe much of our information to our associate, Don Manuel Vicente Ballivian, the distinguished founder of the Bolivian Geographical Society. He has ever been indefatigable in supplying us with geographical news.

The course of the Beni, our most eastern river, is satisfactorily mapped. A very interesting account of its headwaters was given us by Mr. Evans a few years ago. His work has been useful, and has been connected with Sir Martin Conway's triangulation. The course of the Beni was first mapped by Dr. Edwin Heath in 1880, and his detailed work is in agreement with that of Major Fawcett.

The eastern divisions of the map have been perhaps the most difficult. We have a most important fixed position, the longitude by occultation, at Riveralta, the junction of the Madre de Dios and Beni,

and another at the mouth of the Tambopata. All Major Fawcett's work is of course thoroughly reliable. There is a mass of other material from Peruvian and Bolivian sources, which does not always agree or fit, and this has called for no small amount of careful weighing of evidence, and judicious selection. We have to thank Dr. Don Eulogio Delgado, an Honorary Fellow of this Society and President of that of Peru, my excellent friend Don E. Larrabure y Unanue, now Vice-President of Peru, his accomplished son Don Carlos Larrabure y Correa, Colonel Pedro Portillo, Sir Martin Conway, Mr. Bernacchi, Mr. Morkill and the Peruvian Corporation for much assistance, or for the interest they have taken in the progress of the map.

The main object of the Society's map is, of course, to be useful to geographers and travellers. There are still vast tracts with the region covered by the map which are unexplored, almost unknown. The map will also be useful to the historian and to the military student. The march of San Martin over the Uspallata pass is comparable with those of Hannibal and Napoleon over the Alps. That march is not within the bounds of this map. I mention it to show that South American military history is not to be despised. But there are twenty battle-fields within the bounds of the map, from the times of the Incas to those of the Republic. To archæologists our map will be very serviceable, as it includes the sites of eighteen ancient ruins of Incarial or pre-Incarial times. Politically it will be the first map that correctly defines the boundary between Peru and Bolivia, as settled by the Argentine arbitration, modified by a subsequent agreement between the two republics. Another very important object of the map has been to render service to those engaged in mining and other commercial enterprises. For the first time the courses of the great rivers and their tributaries, in this part of the Montaña, have been delineated with any approach to accuracy.

It will have been seen that the compilation and construction of the map has been a very difficult task, and reflects the highest credit on our map curator, Mr. Reeves, and on Mr. Batchelor, the draughtsman, who has acquired a firm grasp of the various intricate points which have constantly arisen.

In conclusion, I wish to express my own satisfaction at the completion of a very important piece of work. It was in March, 1855, fifty-five years ago, that I read my first paper before this Society, on the Montaña of Paucartambo, and in June, 1861, I read my paper on Caravaya. I have ever since been serving on your Council. As President it was my duty to try to be equally interested in every unknown part of this earth, which included an interest in the parts I once partially explored. I have, therefore, done all in my power to advance and promote the discovery of those unknown parts of Peru, and make the progress known to the Society from time to time. At length

the much-desired discoveries are fairly completed, and with a paper on the Society's map, I conclude my geographical labours in this direction, after having worked in your service for a period of forty-eight years.

The PRESIDENT (before the paper): The title of the paper to-night is the Land of the Incas and the reader of it is one who was our honoured President for so many years, Sir Clements Markham. The occasion he has selected for reading this paper is the completion by the officials of our Society of a map of the districts he is going to describe; and the occasion is an appropriate one, for Sir Clements may fairly be described as the father of that map. If it had not been for his initiative, it would never have been commenced and would never have been completed. It is, however, not this map which is now mainly in our minds; it is Sir Clements Markham's paper—a paper which I trust will give rise to an interesting discussion at its conclusion. As for myself, at the present moment my strongest feeling is that I am sitting in the wrong chair. For twelve years Sir Clements was President of this Society, and for all those twelve years I am glad to say I was one of his Honorary Secretaries, and I should feel much more in place to-night if he, not I, was sitting in the presidential chair. Under these circumstances, I am quite sure you will understand that my wish at the present moment is to say nothing more, but to ask my old chief to speak. I will therefore at once ask Sir Clements Markham to read his paper.

The PRESIDENT (after the paper): The extremely interesting paper which we have just heard read will, of course, appear in the ordinary course in the *Journal*. To it will be added a note, drawn up by Mr. Reeves, our Map Curator, giving further information with regard to the compilation and the authorities for the map; and this note will, I am sure, confirm what Sir Clements has said about the extreme difficulty of compiling this map, and as to its being likely to be the best map of Peru for many years to come. As to Sir Clements' paper, it can hardly fail to give rise to an interesting discussion, as there are so many interesting points in it. One suggestion which he has made is naturally of special interest to me, namely, the suggestion—I may say the almost startling suggestion—that the Andes have risen 1000 feet in height since certain stone remains were deposited there by man, thus causing a material alteration in the climate. It is especially interesting to me, because of the mention of my father's name in connection with it. In these circumstances I naturally turned to the 'Voyage of the *Beagle*,' and there I found most ample evidence of the very strong impression that had been made on my father's mind by the evidences on the west coast of South America of great changes in the level of the land. In fact, in the short quotation I propose to read to you, I feel at a loss to know to what extent it should be regarded as sound geology and to what extent as poetic licence. "Daily it is forced home on the mind of the geologist, that nothing, not even the wind that blows, is so unstable as the level of the crust of the Earth." If that were the literal truth, there would indeed be no difficulty in connection with Sir Clements Markham's suggestion as to the rise in the Andes.

In considering this question, what we should like to know in the first place is, what is the age of these ancient ruins? On that point there is no evidence whatever, but judging by the age now generally assigned to the pyramids of Egypt, it would not be an outrageous supposition to suggest that these megalithic remains may be 4000 years old. Then as to the changes of level. Referring again to the 'Voyage of the *Beagle*,' one instance is there given of a rise of 11 feet in

seventeen years. That, of course, is a much greater rise than is necessary to tally with Sir Clements Markham's suggestion, and perhaps it is unfair to quote it, as it no doubt took place in a period of exceptional movement. Another case is given where the rise appears to have been close on 19 feet during 220 years. Let us say, then, it does not appear to be out of the question to suppose that land in South America may have risen 20 feet in 200 years, or 400 feet in 4000 years. But this rise was near the coast-line, and there is ample geological evidence to prove that the rise in recent geological times has been much greater inland than at the coast. If the rise at Lake Titicaca were two and a half times the rise at the coast, and the rise at the coast could have amounted to 400 feet in the assumed time, than we have a possible rise at Lake Titicaca of 1000 feet. Thus it seems to me that the facts we know do not, at all events, run counter to Sir Clements Markham's suggestion. It occurred to me, in considering this question, that if this rise of 1000 feet really took place, it must have shown itself in a tilting of the buildings. This is, however, not the case. If the land near Lake Titicaca rose 1000 feet, whilst the land near the coast remained quite stationary, this would necessitate a tilting of the land to the extent of only five minutes of arc, an amount quite invisible on buildings. But it would, nevertheless, be extremely interesting if any explorer would take the trouble to carefully measure the slopes of the line of masonry in all these ancient buildings, in order to see if there is any indication of any change of slope having occurred. There is only one possible method of noting whether the land near the coast-line is rising or falling, and that is by means of tide-gauges on the west coast of South America, and it is certainly to be hoped that those in charge of them are taking steps to keep such a record as will enable observers in future times thus to obtain the most accurate estimate possible of the movement of the Earth. As to the movements in the interior of the continent, as compared with the coast, I presume the best way of getting at the desired results would be by measurements of vertical angles. Let us hope that the South American surveyors are also keeping this fact in mind, so that by an accurate determination of the vertical angles of some of the highest peaks from the coast-line say a hundred years hence, the best possible estimate of this change may be obtainable. I have, I fear, spoken too long, but my excuse is that I have been provoked to it by my late President, whom I could never disobey.

Mr. Eduardo Lembcke: The last remarks of Sir Clements Markham were that, while he was President of this Society he had to be impartial to all countries, but now that he is no longer President, he will lean to the country he likes best. Having done so much for my country while he was impartial, I hope that he will be able to do a great deal more now, when he is devoting himself entirely to Peru in order to make it better known. Considering Peru, you may say there have been three ages, the ancient, the middle ages, and the present. The ancient, surely, as our President has just stated, may compare with the Egyptian—there are proofs of it. Graves have lately been found containing most interesting pottery of Egyptian and even Indian character. The middle age, the Incaic epoch proper, has much interest from a historical and social point of view, but that is not what we are considering to-night. The present age, certainly, is of great interest from a future point of view, owing chiefly to the possibilities of investment of British capital. With it we have been able to build railways for opening up the country, and it will enable us to work mines which were very productive in olden times when labour was very cheap, but which cannot be worked at advantage to-day for want of communications. I believe that the gold existing in the interior of Peru will astonish the world one of these days. All the rivers carry gold in immense quantities, they wash down rich gravels, and, when proper appliances

will be used, the results will be very satisfactory. I have now to thank Sir Clements Markham most heartily for all the kind words he has said about my country.

Sir MARTIN CONWAY: The fascinating paper to which we have listened may open the way to remarks of all kinds in connection with the area covered by this map. This map, which owes its origin entirely, like so many other geographical products of our day, to Sir Clements Markham's initiative, has been carried through aided by the energy and the continual attention and criticism that he has supplied. I will not speak in general about any part of this district, but there is one special remark I should like to make. That is in connection with the question of the elevation of the land. I made some observations myself in the upper region of Bolivia, which led me to the conclusion (not then knowing it was a conclusion that had been arrived at previously) that the land not only had been, but was continuing to be, elevated in that interior part, and that idea which came to me was very strongly confirmed by what I was told by Mr. Bandelier, who was at that time working in Bolivia, and had been working in Peru on behalf of the American Museum of Natural History. I had observed that there were considerable remains of cultivation at high levels—traces of terraced fields which had been cultivated evidently through long series of years, because the terraces were built up with massive masonry in the most elaborate manner, and these fields were at the present moment far above the level where cultivation is carried on. I thought that might be due to a diminution of the population; but, on the other hand, the diminution of the population at those levels might be due to the contraction of the area. Mr. Bandelier, who had a most minute acquaintance with all the outlying villages at high levels, told me it was pretty nearly a universal feature of these districts. On the slopes of all the highest mountains there are remains of ancient terraced fields which had been cultivated through long series of years, but are now uncultivated, and incapable of being cultivated on account of their high elevation. I was, therefore, led to conclude that the main Andean range has been rising, and is probably still rising at the present day. I think the drying up of Lake Titicaca may be due to a similar cause. As to the coast-line, I have been told, though there I have not been able from personal observation to confirm it, that on the lower slopes, some distance above sea-level, there are found the shells of existing species of marine animals, proving that within relatively recent times those slopes have been under water. For these and other reasons, I think we must conclude that the whole region of the Cordillera has been, and is, rising at a pace sufficiently rapid to affect the climate and the suitability of the higher regions for habitation and cultivation by man. I think that is all I have to say, but I should not like to sit down without expressing the delight which I have felt, and which we have all felt, in once again hearing a paper from our former, much admired and beloved, President.

Sir WILLIAM H. BAILEY said that he had listened with great delight to Sir Clements Markham's address on Peru and the Land of the Incas. There existed no more competent authority. In a jocular manner Sir William said that the only thing he did well at school was to make maps. His map of the world was the largest ever made in his school, and he thoroughly believed that not only his moderate success as a business man was much owing to his knowledge of the map of the world, but that the wonderful business of Manchester and South Lancashire was founded on a knowledge of geography. Modern commerce must have a scientific basis, for science is the perception, acceptance, and utilization of God's creation. The utilization of the productions of the Earth required knowledge of the Earth's surface which we call geography. The ministry to man's necessities

by the knowledge of geography, especially in modern times, has been much improved.

Peru had a lost civilization. Its story is as mysterious as that of Egypt; indeed, we knew more about Egypt than we did of Peru. Both ancient inhabitants believed in the immortality of the soul, and the great discoveries of Mr. Myring of those remarkable works of art—the Chimu pottery—give us a new insight, and teach us something of the skill and intellectual liberty of that ancient race. Of all the great number discovered by Mr. Myring, no two porcelains are alike. Each has its own individuality. Sir Clements Markham is a history-maker. His work and that of such pioneers as Mr. Myring cause us to want more from the same sources.

Mr. T. Hewitt Myring: I would like to say a few words as to what I have myself observed with regard to the elevation of the country between Mollendo and Arequipa. The gist of the remarks made by the previous speakers has been that the rise of the Andes has been gradual. Well, I do not propose to put forward any other theory, but it must be known to all of us who have travelled up to Arequipa and have observed along the line as the Peruvian Corporation's train winds its way to that city, that at a height of about 5000 feet there is a breakaway off one side of a mountain, and that breakaway exposes, at an elevation of 5000 feet or so, a line 6 to 8 feet wide of chalk and shell which extends for a considerable distance, and which shows that that part of the country had been under the sea. Some 80 feet below that sea stratum there is another similar line, and this appears to show that that part of the Andes had been on two separate occasions under the sea. The formations of chalk, the formations of shell, had been, one would think, raised to that height, not by gradual growth, but by a sudden upheaval. If the rise of the Andes had been gradual—so many inches per annum—the whole of that hill would show shell and sea matter interspersed throughout, and not in two clearly defined strata. With regard to pottery. There are evidences in Peru of the existence of a civilization of several thousands of years past. The Incas practically ceased to exist somewhere about the middle of the sixteenth century, but the remains of the Chimu race in the Chucama valley show, by the decomposition of the skeleton, the disintegration of the metals which are buried with the dead, and which I had the good fortune to find, that there was a very artistic and civilized race inhabiting the lower valleys of the rivers from the Andes to the coast some thousands of years ago. These people had elaborate armour, elaborate clothing; they were strictly moral people, inasmuch as the pottery which I found in the graves showed that for several serious crimes, which were depicted by the pottery, the delinquents were put to death; their friends were not allowed to show them any honour after death; the Government, however, would not rob them of a pot of water to take them to the happy hunting-grounds, and placed in the grave one pot which illustrated their crime. In all other cases in which people died a natural death, the various pots which were put into the graves were in many instances of very elaborate workmanship; some of them so very beautiful that experts on the subject of pottery say that nothing finer has been seen from the days of ancient Greece to the present. This pottery proves, by its modelling and drawing, that long before we had any knowledge of art in Europe, in that country, now called Peru, there existed an artistic sensitive race, who wore elaborate clothing, who were well governed and were law-abiding: Peru, which to-day is to many of us a *terra incognita*, was one of the most civilized parts of the earth. Sir Clements Markham's paper to-night has been of great interest to me, because I had the good fortune to travel over part of the country he has so graphically described. As to Lake Titicaca, which he says is now drying up,

when you are on it you feel you are at the top of the world. The mountains which come down to it we know are 18,000 to 20,000 feet high; in the winter the snow covers them to the water's edge, and gives one the impression I have mentioned. I thank Sir Clements very sincerely for his very interesting paper to-night; every word he has said, so far as my knowledge of Peru and Bolivia goes, is absolutely correct in all respects.

Mr. JOHN B. MINCHIN: I should like to add a few observations to the extremely interesting paper of Sir Clements Markham; having lived for some years in Bolivia, which was formerly called Upper Peru, it may be considered a part of the land of the Incas. Bolivia has remained, until recent times, comparatively isolated from the world, but it is now getting gradually opened up. The South Peruvian railway from the port of Mollendo to Arequipa and Puno was made over thirty years ago; then the first railway in the country itself was constructed from Antofagasta to Oruro, a distance of over 900 kilometres. More recently the navigation of Lake Titicaca has been placed in communication with La Paz by railway, and quite recently that has been prolonged to Oruro. Of the railways in adjoining countries which affect Bolivian trade I might mention the Central, Northern, Argentine, which has reached the frontier. The line from Arica to La Paz is being made, and the Madeira railway is under construction also, and when completed it will communicate the navigation of the Amazon with that of its tributaries the Mamore, Beni, and Itenez, and open up an immense region in the heart of South America. The principal centres of population in Bolivia are near the tableland, and consequently are at elevations of from 8000 to 12,000 or 13,000 feet above the sea-level. The only city of importance in the tropical part of the country is Santa Cruz, which is at a height of some 1200 feet. A section of this part of South America presents some interesting features. Coming from west to east, there is an abrupt rise of some 1500 feet to the desert of Atacama, where the celebrated deposits of nitrate of soda exist. This desert extends to the foot of the western range of the Andes, which rise to heights of from 18,000 to 19,000 feet. There is then a drop on to the Andean tableland. This tableland, although it is crossed by various ranges and groups of hills, is extremely level, and it extends to the east or main range of the Andes, amongst the culminating heights of which (?) are the Sorata and Illimani. Sorata rises to a height of some 22,000 feet, and Illimani a little less. So far, I believe, Sir Martin Conway is the only one who has ascended Illimani, and the ascent of Sorata has not been made yet. I do not know if any attention has been paid to an ancient lake which occupied formerly a great part of the Andean tableland. I estimate it to have covered from 12,000 to 15,000 square miles. I found the old water-mark at a height of 200 feet above the level of the plains. This water-mark consists of a calcareous deposit on the ancient rocks, and in some places is composed almost exclusively of small shells. I should like to call the attention of the Society, in case any members happen to visit La Paz, to a remarkable stratum which is found in the deep ravine in which the city of La Paz is situated. This stratum is some 20 feet thick, and it is composed of volcanic ashes; it extends southwards for 50 or 60 miles and perhaps more, and it has evidently been deposited under water. At present it is covered with several hundred feet of gravel, probably brought down from the neighbouring cordillera at the time of the glacial age. The river of La Paz is, I think, unique in taking its rise on one side of such a cordillera as the Andes, and later on cutting through the same range in the immense gorge at the foot of Illimani. The difference of level between the present bed of the river at this gorge and the stratum I have mentioned must be at least 6000 feet, and I think a study of those facts might throw a very great

light on the question of the topography of the region. In connection with the ancient lake, I think the stratum has been deposited during the time of the lake, in which case the levels of the country would be very different to what they are at the present day. That is also in connection with the suggestion that has been made of variations in the level of that part of the continent.

The PRESIDENT: I have already acknowledged my difficulty in thanking Sir Clements Markham in suitable terms, because I cannot help still looking upon him as our President. I think to have had two papers read by the same author fifty-five years apart is certainly a record. And as a record there is only one chance of its being broken—and that is if Sir Clements Markham will himself break it a few years hence, as I certainly trust he will. I am sure in your name I may thank our late President most sincerely for his extraordinarily interesting paper, and for all that he has done for us in the past.

Sir CLEMENTS MARKHAM: I have only voice left to thank you very cordially for your very kind reception.

Colonel Sir T. H. HOLDICH sends the following remarks: The investigations of the Chile-Argentine Boundary Commission on the Pacific coast did not lead to the conclusion that the coast regions and western Cordillera had been gradually and uniformly raised in altitude. We found (as Sir Martin Conway stated) modern sea-born organisms raised some hundreds of feet above sea-level. But we also found submerged forests of which the upper part of the trees was distinctly visible. Alterations in level have been irregular and spasmodic (Moreno likened them to the action of a concertina), although the main effect has been one of an elevating tendency.

The Chilian Government has been carrying out their coast surveys on most excellent principles, and the official determination of altitudes can never be amended in any way by amateur observations from the sea-level. At present the Argentine and Chilian values of altitude in the Cordillera do not agree with any precision. But they never will agree until some common datum of mean sea-level can be determined. This will take many a long year of tidal observation to bring about. In short, it will be a very difficult problem to determine the exact relationship between a mean sea-level and the altitude of the Andine peaks.

It may also be noted that lakes are diminishing in size everywhere, and glaciers are receding.

The following has been sent by Mr. REGINALD ENOCK: The subject of the recent elevation of the Andes is of much interest, and one to which, after having travelled extensively in Peru and Chile, I have given a good deal of thought. The theory advanced that the Cordillera has risen since the time of the megalithic structures of the Incas and pre-Incas must be considered a very debatable one. It seems scarcely conceivable that these ruins, often composed of stones beautifully fitted and poised upon each other, could have remained in place without suffering derangement from such earth-movement. Of course, as all students of the Peruvian ruins are aware, these buildings are of two widely separated epochs. Those groups known as Tiahuanako, Chavin, and others are of the remote Aymara period, and their age may be measured possibly by thousands of years, whilst those of Cuzco, Huanuco, etc., are probably of comparatively recent times, measured by a few hundred years only. The castle of Chavin stands close upon the bank of a river. Is it conceivable that if the Andes had risen several thousand feet since the castle's construction, the waters of this river would have flowed on unaltered as before? Many of these ruins exist at elevations greatly above the region where corn will now grow, which is adduced as a possible reason for elevation

subsequent to their construction. But maize will not grow in the Andes much beyond 10,000 feet, and Tiahuanako is 12,500 feet or more; and some of the other ruins which I examined, with extensive ancient villages surrounding them, are at 16,000 in some cases. So that the elevation from a supposed original corn-growing level would have had to be very considerable. Further, there would seem to be a point against the theory, in the matter of the snow-cap. There are strong indications that this has been, and is, retiring. I have crossed the Andes repeatedly at points between latitudes 9° and 21° S., and noted this fact. If the Andes had risen so recently, it might be supposed that the edge of the snow-line would be found lower rather than higher, or rather, the diminution would have been balanced by the raising, and the line remained constant. The conclusion that I, personally, have reached, is that there have been changes of climate, rather than elevation, since the time of the prehistoric stone structures, and of their probable Asiatic originators.

The new map of the regions of the Cordillera and Montaña, both, should be of much value to those engaged in opening up those remote places. Gold and rubber are the main products at present of the lower eastern slopes, but there are vast tracts of splendid agricultural lands along the full-flowing rivers of the Peruvian Amazon plain, such as must soon acquire importance. The Montaña is one of the most valuable parts of Peru. These regions are not necessarily unhealthy, and, indeed, in some cases enjoy a delicious climate.

NOTE ON MAP OF SOUTH PERU AND NORTH BOLIVIA.

By E. A. REEVES.

THIS map extends from 8° to 18° S. lat. and from 65° to 74° W. long. The river Madeira is continued, on an inset, about 1° in longitude further to the east, in order to show the railway under construction past the rapids and the port of San Antonio, the position of which has been well determined, and is important for the adjusting of this part of the map. The area included in the map, altogether about 418,000 square miles, is, apart from its present importance in connection with commercial enterprises and boundary questions, one of the most interesting on the surface of the Earth from historical, geomorphological, climatological and other points of view.

The original compilation and drawing has been made on the scale of 1 : 1,000,000, in four sheets, which will be corrected and added to from time to time as new exploratory and survey work is completed. For the purpose of publication the map has been reduced to one sheet, measuring 22 inches by 19 inches, on the scale 1 : 2,000,000, or half that of the original, and this, until more complete surveys are made, is large enough for showing all important features. With the exception of a few names and a certain amount of smaller detail, little has been lost by the reduction.

The map is drawn on a conical projection with two standard parallels, which have been computed on the principle that errors on the limiting parallels of the map shall be equal to those on the middle parallel, which, in round numbers, holds good in this case for 9° 30′ S. and 16° 40′ S.

No regular surveys exist of this region as a whole, nor are any likely to be undertaken for years to come; consequently, for the greater part of it, any mapping must depend upon rough sketches and route traverses, either overland or by boat. These naturally vary considerably in merit, and in some cases where astronomical observations have been taken, are doubtless fairly good. The compilation and drawing of this map has taken the greater part of two years, and has necessitated comparing and determining the value of a large amount of cartographical material, and many observations.

In the first place, it was necessary to decide as to what parts had been most accurately surveyed, and positions determined with sufficient reliability to form a basis for the map to which the more approximate work could be adjusted. The coast-line was laid down from the latest Admiralty charts, and probably leaves little to be desired. Then, as regards the interior regions, latitude and longitude observations taken at various places were fully considered, and in the end the results given on the following table were accepted. Many observations had to be rejected as unreliable, and in a great number of cases the latitudes only were used, the longitudes being rejected altogether, or, where there was reason to believe that the chronometric differences between places were fairly correct although the absolute longitudes as regards Greenwich might be in error, these differences were utilized, and the work adjusted accordingly. As an example of this may be mentioned the case of Pto. Maldonado, at the junction of the Tambopata with the Rio Madre de Dios. Here an occultation of a star was observed in 1904 by Captain Juan M. Ontaneda, of the Peruvian Fluvial Commission, to determine the longitude, the computation of which he gives in his report. This has been recomputed with little difference in result; so the longitude assigned to this place is probably but a few miles in error at most. This has been accepted, and the remaining work in the region, including chronometric differences of longitude by Don Jorge von Hassel and other Peruvian officers, adjusted to it. The course of the Rio Purus and lower Aquiry has been plotted, without alteration, from the excellent surveys of those rivers made in 1866 and 1867 by the late W. Chandless, published in the *Journals* of this Society. Careful astronomical observations were taken to correct the surveys, and as examples of pioneer river exploration, nothing could be better than the work of this explorer. The upper course of the Aquiry was also mapped by Chandless, but it has lately been re-surveyed in greater detail by Major P. H. Fawcett, R.A., the present Commissioner for the Bolivian Boundary Surveys. The agreement between the river as laid down by these two surveyors is, on the whole, very good

Major Fawcett's recent surveys include the lower course of the Beni, the Rio Abuna, and upper Aquiry, and he has been good enough to place his original documents at the disposal of the Society. In addition to his

route traverses, he has taken numerous observations for latitude and longitude in this region, including occultations at Cobija Capatara on the Aquiry or Acre, Riberalta on the Beni, and Bon Futuro on the Abuna, and his work has been utilized, without alteration, in the compilation of a great part of the north-eastern section of this map.

As regards the high plateau region, the available cartographical material that may be considered most reliable, and which has been utilised as the basis of this part of the map, are the following: surveys for proposed railways, with distances and levels along traverse lines, specially those published in Vol. 3 of the 'Intercontinental Railway Commission Report,' 1891–92, from which the country from Arequipa to Puna, and Juliaca to Cuzco, have been taken. The 'Triangulation of the Cordillera Real,' by Sir Martin Conway, 1898; 'Route Surveys in Caupolican,' by Dr. J. Evans and Mr. Watney, 1902, adjusted by bearings to Conway's triangulation, and by astronomical observations for latitude; 'Bathymetrical Survey of Lake Titicaca,' by Dr. Neveu-Lemaire, 1903.

In the southern part of this area a portion of the Tacna Province of Chile is included, and for this the new surveys of the Chilian Boundary Commission have been utilized. This contains a large amount of detail, and is probably more correct than almost any other part of the map. The positions determined by Mr. J. B. Pentland in Bolivia and Peru from astronomical observations and triangulation, so long ago as 1827–38 are still the most reliable for the plateau regions in many instances, and those adopted in the map are given, with others, in the list at the end of this memorandum. In addition to those already mentioned, there are at least three other positions that call for special notice, the first of these is Arequipa, the latitude and longitude of which has been accurately fixed by Winslow Upton, the latter (71° 32′ 55″ W.) being determined by telegraph from Arica. This value, in conjunction with that of La Paz (the latest value of which is 68° 9′ 25″ W.) serves as a basis of adjustment in longitude for all this part of the map, and has necessitated moving the longitudes of Conway's triangulation and other maps depending upon it about 9′ 00″ to the west of the position previously given. Then there is the position of Cuzco, which has been fixed by several travellers at different dates, including Sir Clements Markham in 1853. The mean of the results of Gibbon, Markham, Squier, and Pentland have been accepted, as given in the table. It is interesting to note that in no case do their values differ more than 41″ in lat. and 2′ 10″ in long. The longitude of this place was in every instance obtained by chronometer.

In addition to the above, which are the more important surveys of special districts used in the compilation of this map, many others, principally rough route traverses, or compilations from route traverses, have been utilized in filling in detail and gaps where nothing better exists. All of these will be found in the list at the end, but among the

most important are several manuscript and printed compilations of recent work, kindly supplied by the Lima Geographical Society and others, and the map of Peru, on the scale of 1 : 500,000 by Dr. A. Raimondi. Except for the few special maps mentioned in the annexed list, this latter has been extensively used in the Peruvian section, as in many parts nothing better so far exists. For the plateau of Bolivia the surveys of J. Minchin, in 1881, and others, combined with the 1 : 750,000 general French map of the Mission G. de Créqui Montfort and E. Sénéchal de la Grange of 1903, form the basis of the compilation when no later or more detailed material has been available.

The heights on the map vary considerably in degree of reliability. Along the lines of railways and traverses these are doubtless fairly correct, as they depend on levelling. In the neighbourhood of Lake Titicaca and to the south-east in the Illimani district they should not be greatly in error, as they are chiefly from theodolite vertical angles. Then, again, to the south, in the district covered by the Chilian Boundary Surveys, they may be depended upon. But apart from these regions they must be considered as only approximate, since they are chiefly based upon aneroid and boiling-point readings, or are merely estimations.

MATERIAL USED IN THE CONSTRUCTION OF THE MAP.

1. Admiralty Charts Nos. 1279 and 1283.
2. Surveys of the Northern Boundary of Bolivia by Major P. H. Fawcett. 1907.
3. The Cordillera Real, Bolivia. From a Triangulation and Plane Table Survey by Sir Martin Conway. 1898.
4. Surveys of the Comision Chilena de Límites, 1908.
5. Mapa del Peru. A. Raimondi. Scale 1 : 500,000.
6. Caupolican and adjoining portions of Northern Bolivia. Compiled from the Surveys of G. N. Watney, C.E., J. W. Evans, D.SC., and others. 1903.
7. International Railway Commission. Vol. 3. Reports of Surveys and Explorations made by Corps No. 3. 1891 and 1892.
8. Vías del Pacifico al Madre de Dios. Vías del Pacifico al Marañon. El Istmo de Fitscarrald. Publicación de la Junta de Vías Fluviales. Lima, 1902–3.
9. Nuevas Exploraciones en la Hoya del Madre de Dios. El Istmo de Fitscarrald. Publicación de la Junta de Vías Fluviales. Lima, 1904.
10. Ultimas exploraciones ordenadas por la Junta de Vías Fluviales. Lima, 1907. These are three important reports, with maps, comprising surveys of the rivers Tambopata, Madre de Dios, Inambari, Mishagua, Serjali, Manu, Cashpajali, Tacuatimanu, Tavara, Sepahua, Urubamba, and the Istmo de Fitscarrald, by the following members of the Commission: Captain J. M. Ontaneda, Don J. S. Villalta, Don Fernando Carbajal, Don Germán Stiglich, Don C. A. Cipriani, Don J. von Hassel, Colonel D. E. de la Combe, Don J. M. Torres, Don J. M. Olivera.
11. Carte Bathymétrique du Lac Titicaca par le Dr. Neveu-Lemaire, 1903.
12. Mission G. de Créqui Montfort et E. Sénéchal de la Grange. 1903. Régions des Hauts Plateaux de l'Amerique du Sud (Bolivie, Argentine, Chili, Perou). Carte dressée par V. Huot d'après les Travaux des Membres de la Mission, les sources originales inédites, et les Documents les plus récents. Scale 1 : 750,000.

13. The Rio Purus, by Wm. Chandless. 1867.
14. The Rio Aquiry or Acre, by Wm. Chandless. 1866.
15. Mapa de los Rios Beni y Yacuma segun las exploraciones del Dor. Eduardo R. Heath. 1879, 1880, 1881.
16. Route Surveys by C. R. Markham. 1853 and 1860.
17. Plano General del Rio Desaguadero por Juan Bergelund. 1892.
18. Surveys of parts of Bolivia by J. B. Minchin. 1882.
19. Mappa topographico da Valle de Rio Madeira levantado pelos engenheiros José e Franc°. Keller. 1868.
20. Croquis de la Region fluvial Peruana del Yurua, Purus, Madre de Dios i Beni. Trabajado bajo la direccion del jefe de la Oficina Dr. Carlos Larrabure y Correa. Lima, 1906.
21. Mapa indicando el Resultado de las ultimas Exploraciones en los rios Paucartambo y Madre de Dios. Lima, 1904.
22. Mapa Historico Geográfico de los Valles de Paucartambo. Scipion E. Llona. Lima, 1904.
23. Croquis de la Frontera Peruana-Brasileña. Archivo Especial de Limites. 1909.
24. Region Oriental del Peru. Estudiada por los SS. Mavila, Stiglich, Donaire, la Comision Peru-Brasileña y el Sr. F. Gabrielli. Trazada por encargo y según los datos proporcionados por el Coronel Don Pedro Portillo. Lima, 1906.
25. Departmento de Apurimac. Provincias de Antabamba, Cotabambas y Aymaraes. Croquis de Ing°. Alberto Jochamovitz. Cuerpo de Ingenieros de Minas del Perú. Boletin N. 58.
26. Plano de las Secciones y Afluentes del R. Urubamba levantado por Luis M. Robledo. Lima, 1902–1904.
27. Vallée de Santa-Ana. Depuis le col de la Cordillère Orientale jusqu' aux Cerros de Ichitariato, dressé et dessiné par Ch. Wiener. Paris, 1880.
28. Camino de Herradura de La Paz à Puerto Pando. Segun estudios comparativos hechos por las vias de Coroico y Chulumani por Julio Knaudt. La Paz, 1907.
29. Exploration de la Vallée du Marcapata, relevé par A. Plane. Paris, 1903.
30. Portion of the Rio Inambari. Sketched from a rough survey made November, 1907, by J. C. Quinn.
31. Mapa de los nuevos limites de Bolivia con el Peru en la región litigiosa Madre de Dios-Aquiry Conforme al nuevo Tratado de Setiembre de 1909.
32. La Laguna de Titicaca and the valleys of Yucay, Collao, and Desaguadero in Peru and Bolivia. From Geodesic and Astronomic Observations made in the years of 1827, 1828, 1837, and 1838, by J. B. Pentland, Esq.
33. The Surveys of the Concessions of the Inambari Pará Rubber Estates, by J. G. V. Bonvales. 1909.

NOTE.—Many other maps and sketches were examined with a view to their being used, but were afterwards rejected, or were only serviceable to a small extent.

LIST OF POSITIONS.

Place.	Latitude.	Longitude.	Observer.	Authority, Remarks, etc.
	° ′ ″	° ′ ″		
Ancoraimes ...	15 54 0 S.	—	La Puente	'Les Lacs des Hauts Plateaux de l'Amerique du Sud,' p. 50.
Ayaviri ...	14 52 50	—	Pentland	

Place.	Latitude.	Longitude.	Observer.	Authority, Remarks, etc.
	° ′ ″	° ′ ″		
Arequipa ...	16 22 28	71 32 55 W.	Winslow Upton	Long. by Telegraph from Arica.
Azangaro ...	14 55 10	—	Pentland	
Bahia ...	11 1 0	68 46 47	Major Fawcett	Long. by Occultation.
Bon Futuro ...	9 47 20	66 8 15	Major Fawcett	Long. by Occultation.
Caracoto ...	15 34 20	—	Pentland	
Capatara ...	10 15 47	67 53 2	Major Fawcett	Long. by Occultation.
Copacabana ...	16 19 56	—	Pentland	
Pto. Candamo	13 29 30	69 53 3	Ontaneda	Publicación de la Junta de Vias Fluviales.
Chililaya ...	16 17 4	—	Bergelund	'Les Lacs des Hauts Plateaux de l'Amerique du Sud,' p. 50.
Cuzco ...	13 30 41	72 4 30	Gibbon, Markham / Squier, Pentland	Mean result as taken by Raimondi.
Desaguadero R. (mouth)	16 33 10	69 2 31	Pentland	Mean taken.
Desaguadero R. (mouth)	16 33 52	69 2 23	Bergelund	'Les Lacs des Hauts Plateaux de l'Amerique du Sud,' p. 15.
Escoma ...	15 40 1	—	Pentland	
Atuncolla ...	15 42 0	—	Pentland	
Huancane ...	15 12 3	—	Pentland	
Huaqui ...	16 35 27	—	Bergelund	'Les Lacs des Hauts Plateaux de l'Amerique du Sud,' p. 50.
Juli	16 11 50	—	Pentland	
Juliaca ...	15 29 20	—	Pentland	
Pto. Markham	13 20 50	69 50 33	Ontaneda	Publicación de la Junta de Vias Fluviales. Long. by Occultation.
Pto. Maldonado	12 35 40	69 15 40	Ontaneda	" "
Nao R. (mouth)	12 55 30	69 41 59	Ontaneda	" "
Puno	15 50 35	—	Bergelund	'Les Lacs des Hauts Plateaux de l'Amerique du Sud.'
Riberalta ...	10 59 50	66 5 26	Major Fawcett	Long. by Occultation.
Rames ...	15 19 0	—	Pentland	
Pomata ...	16 19 0	—	Pentland	
Pucara ...	15 2 10	—	Pentland	
San Antonio	8 48 13·4	63 56 7	Com. Davis and Lieut. Norris	U.S. Navy, 1882; United States Hydrog. Office, Chart No. 897.
Sandia ...	14 23 1	—	Stiglich	Publicación de la Junta de Vias Fluviales.
La Torre R. (mouth)	12 48 50	69 27 33	Ontaneda	" "
Pto. Seco ...	13 31 30	69 25 15	Ontaneda	" "
La Union ...	13 31 20	69 47 27	Ontaneda	" "
La Paz ...	16 29 57	68 9 25	—	'Geografia de la Republica de Bolivia' (La Paz, 1905).
Oruro ...	17 53 52	67 19 17	—	
Urubamba ...	13 18 30	72 11 22	Pentland	" "
R. Sepahua and Urubamba junction	11 3 5	—	Olivera	Publicación de la Junta de Vias Fluviales.
R. Mishagua and Urubamba junction	11 10 33	—	Olivera	" "
R. Manu mouth	12 16 22	—	Stiglich	" "
R. Inambari mouth	12 42 21	—	Stiglich	" "
Puerto Oriental del Istmo de Fitscarrald	11 49 10	—	Stiglich	" "

Place.	Latitude.	Longitude.	Observer.	Authority, Remarks, etc.
	° ′ ″			
R. Heath ...	12 31 14	—	Torres	Publicación de la Junta de Vias Fluviales.
R. Purus ...	The positions on these rivers, from observations by Wm. Chandless, so far as they come within the limits of the map, have been retained. A list of the latitudes and longitudes, including several occultations, is given in the *London Geographical Journal*, vol. 36, 1866, pp. 115, 126.			
R. Aquiry or Acre				
Ixiamas ...	13 45 0	—	Watney	
San Rafael ...	14 1 0	—	,,	
San Martin ...	14 6 0	—	,,	
San Juan ...	14 10 0	—	,,	
Buturo ...	14 17 0	—	,,	
Asilla ...	14 27 6	—	,,	
San Jose ...	14 13 0	—	,,	
Tumupasa ...	14 9 0	—	,,	
San Buena Ventura ...	14 26 0	—	,,	
Apolo ...	14 43 0	—	,,	
Aten	14 55 0	—	,,	
Pelechuco ...	14 49 0	—	,,	
Mariara ...	15 15 0	—	,,	
Maqnique ...	15 23 0	—	,,	
Isapuri ...	15 26 0	—	,,	
Charapampa ...	15 15 0	—	,,	

NOTE.—Where not otherwise stated, the longitudes are by chronometer. In addition to the above longitudes, in several instances chronometric differences were used after being adjusted to fixed points.

MR. CARRUTHERS' EXPEDITION TO NORTH-WEST MONGOLIA.

MR. DOUGLAS CARRUTHERS has sent us a short report on the first stage of this expedition, which, it will be remembered (see *Journal*, vol. **35**, p. 333), set out early in the present year for scientific exploration in the extreme upper basin of the Yenesei and other parts of Mongolia. Some excellent work seems to have been already accomplished, from the point of view both of geography and of natural history. At the time of writing (July 25), the expedition was at Cha-kul on the upper Yenesei, having left Minusinsk in May and traversed the Saiansk and Bei-kem districts of that region, drifting in rafts for 300 miles after reaching the Bei-kem river. As a result of the journey it had been ascertained that the supposed main range of the Saiansk mountains (shown on the maps) has no existence, its place being taken by isolated groups of very rough, rugged mountains. These seem to owe their origin to a series of disconnected uplifts, which have taken place in different directions and at different periods. The river systems are divided from each other by almost imperceptible water-partings. Many glacial lakes not marked on existing maps—some of large size—were met with. A striking fact is the close affinity which this country possesses with Siberia, not with Mongolia. The climate,

scenery, people, flora and fauna, are all Siberian. Dense forest covers the greater part of the surface, the dry Mongolian flora beginning to appear only in the valley-bottoms and southern slopes of the hills around Cha-kul. The region is inhabited, in small numbers, by the Urianchais, who show greater affinities to the southern Siberian tribes than to the Mongols. In the remote upper valleys in the heart of the forest, nomads were encountered, living in birch-bark wigwams, and entirely dependent for their subsistence on their herds of domesticated reindeer. The existence of these animals within the Chinese Empire is of great interest, the more so as proof was obtained that reindeer are indigenous to the country, being found in a wild state also. The further route of the party was to be westward up the valley of the Kemchik (giving an opportunity for investigating the Tannu-ola mountains en route) and across the Altai to Chuguchak and Kulja, which last would be reached probably about the end of October. Owing to the inaccuracy of existing maps, a careful survey of the whole route through the upper Yenesei region had been made by Messrs. Carruthers and Miller, some 1800 square miles being mapped. They had also secured a good number of zoological specimens, while considerable botanical and geological collections had been made by Mr. Price.

ON THE BORDER OF THE GREAT DESERT: A JOURNEY IN OMAN.*

By Lieut.-Colonel S. B. MILES.

The Beni Hina tribe is one of the Al Azd stock, and emigrated from the Yemen at the same time as the Beni Riyam. Owing to the leading part taken by this tribe under its famous leader, the Dwarf Khalf, during the civil war which threatened the Yaarebeh dynasty at one time, it has given its name to one of the two great political factions, viz. the Hinawi and Ghafiri, into which Oman is at this day divided. Shaikh Hilal informed me that he had a thousand men-at-arms at his disposal at Nezwa alone, and he reckoned the whole population, including the Riyamis, at ten or twelve thousand, an estimate that seemed to me to be considerably under the mark. The great fortress, I was surprised to find, does not occupy an elevated position, but is situated in a thickly peopled quarter, and is hemmed in on all sides by dwelling-houses. It may be described as consisting of a large quadrangular enclosure, called the Hisn, at one angle of which stands the Kilaa, or citadel, a huge circular tower of solid stone masonry without window, loophole, or embrasure, but rising sheer, smooth, and unbroken to the roof, on which

* Continued from p. 178.

are mounted several parapet guns. The walls are of prodigious thickness and substantiality, and are well preserved; it is, therefore, easy to conceive that in a country where a prolonged investment and blockade are practically out of the question owing to the absence of commissariat organization, as well as to the non-existence of siege artillery, the castle might, if well provisioned, stand out for a long period. Its unquestionably massive structure is manifest at once, and its fame throughout Oman for its impregnability is intelligible enough; but the impression conveyed to my mind by its appearance after what I had heard of it from the Arabs, who invariably speak of it with conscious pride, was one of disappointment. I of course considered myself precluded from taking any measurements, but I may add that Wellsted's estimate of the height seemed to me to be too great by half. Commenced about four centuries ago on the site occupied by the ruins of an ancient tower of the Imams of the Nebhani dynasty, it was subsequently remodelled by some of the Yaarebeh Imams, and was finally brought to completion as it now stands by the Imam Sultan Belarab, who is alleged to have expended on it some eighty thousand dollars. The chief battle-ground lies in the open plain to the south-west of Jebel Akhdar.

The intertribal warfare of the Arab has generally been in the mountain passes when they could choose their own ground, but the plains have always been the arena when they fought in self-defence, and when battles have been forced on them by the invading armies of the Persians, Seljooks, Khalifs, or Wahabees. Resting at the base of the great mountain which overhangs and shields it on the north side, the town occupies a gentle slope intersected by many converging streams and nullahs, and screened from view towards the south by broken ground and low hills, the summits of which are often crowned with towers. This site, so extremely well adapted for defensive operations, gives it an unrivalled position, strategically and commercially, and it offers a haven of security and protection in this land of predatory and lawless marauders to the merchant, while it possesses an additional coign of vantage in commanding the mouths of the three passes leading from Jebel Akhdar, viz. the Wadi Tanuf, Wadi Miyadin, and Wadi Miyan, as well as in its proximity to Zikki, by which it draws to itself the traffic that is carried on up the Wadi Semail from the coast.

Here it was that the Azdite emigrants from the Yemen under Malik bin Fahm in the second century after Christ first established themselves, after having dispossessed and driven off the Parthian occupants of the land. Here it was that the messengers sent by Mohammed from El Medina delivered to the Julanda princes Abd and Jeifar the letters inviting them to accept the new faith of Islam, and abandon the idolatry of their fathers.

It was towards Nezwa as the capital that the many successive waves

of invasion were directed, and here on the plains below were encamped at various times the imperial troops of Haroon al Rashid and other khalifs of Baghdad, the relentless and rapacious Seljooks of Kirman, and other Persian invaders. Here, too, the heretical Omanis fraternized with their schismatic neighbours the Carmathians of Al Bahrain, and it was in the Jami mosque of Nezwa, in the third century of the Hijra, that Abdulla bin Ibadh preached his peculiar doctrines and tenets so successfully that he gradually converted almost the whole country to his views. In this capital a long line of imams or sovereign pontiffs had ruled the destinies of the people and guided the main incidents and events of the chequered life of the nation during the period of a dozen centuries.

I was amused by the visits of the son of the owner, a bright little fellow of twelve, who, being naturally inquisitive, was full of questions about all he saw, and was delighted with the silver watch he received when I left.

I stayed a night at Tanuf, which is 8 miles from Nezwa, on our way to Al Dhahirah, as I had promised Shaikh Suliman when he intercepted us on the road, and had reason to be glad that I had accepted his invitation, as he received me very cordially, and gave me much information, though I could but ill-spare the time.

Tanuf is a small, compact town of the Beni Riyam, fortified with a wall of fair height, pierced by two gates, the eastern and the western. The shaikh's house is behind the town, picturesquely built on the very edge of the deep ravine known as Wadi Tanuf, and which, cutting into the heart of the mountain, forms the natural road leading to Seek. Another deep gully or torrent-bed, also debouching at this point in the Wadi Mayin, which penetrates in a more northerly direction and forms a pass, albeit a very rough and precipitous one, across the chain to Rostak, is called the Tareek al Shas. The dark limestone cliffs, the cavernous glen, and the palm trees give a gloomy and sombre aspect to this spot, which has a romantic air of seclusion, and I was not surprised to learn that, shut in as it is, the heat here in the summer months is intolerable.

Shaikh Suliman informed me that Jebel Akhdar extended from the Wadi beni Rowaiha to Jebel Shoum, which was the highest peak in Oman, and he confirmed the tradition that the original Azdite name of Jebel Akhdar, as also that of Nezwa, was Radhwan, and was so called probably after a district in the Yemen. When it was first named Jebel Akhdar is unknown, but after the founding of the town of Shiraizi by the Dailemites about 975 A.D., the mountain seems to have been known for a long time as Jebel Shiraizi.

On the 22nd, having procured fresh baggage camels at Tanuf, and said farewell to the shaikh, who had treated us so urbanely and hospitably, we mounted just outside the gate, and turning our camels'

heads to the north-north-west in the direction of the Akabat al Barak, by which pass we intended to cross over to the Dhahirah, rode off to pursue our journey. The path lay over a monotonous, drear, and stony plain, crossed by numerous nullahs. We passed several villages of the Beni Hina tribe, such as Homra, with a population of about four hundred, and other villages, whose names I omitted to record, and further on, between 10 and 12 miles from Tanuf, two hamlets of the goat-rearing shepherds, viz. Ghomriya and Belad Sait. The popular excitement among these rude and unsophisticated people caused us some amusement, and relieved the day's journey from the tediousness and fatiguing dulness it would otherwise have had.

As we approached Ghomriya, the sudden fire of the matchlocks and the whizzing of the bullets, a salute with which the sentries did not fail to greet us, caused a slight scatteration among our timid camels, and proved that our strange appearance had evidently given rise to as much apprehension as suspicion among the inhabitants, who meant their shots as a warning to keep a respectful distance. It was necessary for our kefeer, the Kelbani shaikh, to ride forward and represent who we were, before their fears were sufficiently allayed to allow us to pass by quietly. We soon discovered that the cause of the panic was due to the fact that a troop of Jenebeh Beduins had ridden rapidly by during the previous night from the east. The latter are at feud with the Beni Hina, who had mistaken our party for the Jenebeh returning to raid the district and lift the camels; hence the scare that had been created, and the vigilant distrust with which we had been regarded.

Some of my party at once examined the ground, and having detected fresh footprints of the dromedaries, could judge that the Jenebeh were in force. That they were actuated by no friendly intentions seemed probable, but whither they had gone no one knew. We also heard to-day that a band of seventy marauding brigands, collected from various predatory tribes in Al Dhahirah, had started on an excursion to harry and plunder the peaceful and prosperous peasants in the outskirts of Minha, and that they had, after crossing the Nejd el Makhârim, camped in the vicinity of Yabreen on the night of the very day we had left it. Shaikh Nasir al Ghafiri, the chief of Bahila, had despatched a kossid with a letter after us, giving warning about these robbers, who were said to be mounted on swift dromedaries, directly he had received intelligence of their proximity; but his kossid had missed us on the road, and had not had the sense or courage to follow us on to Nezwa. These marauding gentry are usually averse to hostilities, and prefer to swoop down on their quarry and carry off their plunder as expeditiously as possible before the villagers can assemble to oppose them. It was just as well that we did not encounter them, for, although my party was quite a match for them, it would have been regrettable had any bloodshed occurred even in self-defence.

After a ride of some hours over a rough country, very scantily dotted with vegetation, we reached the fort of Jebel Kur. Here we strike the Wadi Shama, and having crossed this we commence the ascent of the Wadi Ghol, which presents at this point a broad, sandy, and shallow bed not devoid of trees and other vegetation. These two wadis, the Ghol and the Shama, uniting lower down, are then known under the name of the Wadi Bahila, a torrent which, as I have above described flowing under the walls of that city, loses itself ultimately in the sands of the desert. The Wadi Ghol is not particularly serpentine, and I imagine it is so called because it abounds with snakes. Ghol is the common word used in Oman for this reptile, and in this wild hilly district they are tolerably numerous. Though poisonous species do exist in this land, the great majority of species are, I believe, innocuous, and cases of Arabs dying from snake-bite are extremely rare. Indeed, they appear to regard them but little, and seldom allude to them.

The bed of the Ghol, which is cut through high vertical banks, and contains a perennial supply of water, is occupied by several hamlets of the Yal Khameyyis, a Beduin branch of the Beni Hina, who lead a pastoral life and subsist mainly on their flocks of goats and sheep. It is to the vigilance of these hardy, active, and brave hillmen that the security of this pass is due, as, being ever on the alert, they are able to gather with marvellous quickness on the sign of danger, and thus hold in check the plundering bands of Al Dhahirah, who would otherwise be free to raid and devastate this district at their pleasure. After toiling for two hours up the bed of the wadi, which gradually becomes more steep and stony, we arrived at a shepherd hamlet called Mithar, where we bivouacked for the night at an elevation of 2600 feet. At this place was a very large zareeba or fold for the goats, from which we kept a very respectful distance. The thermometer fell heavily during the night, and I was glad of all the wraps I had with me.

The next morning we started at 7 a.m., and underwent a hard day's work of nine hours in crossing the pass; the severe gradient we had to climb, and the rugged nature of the rocky ground—for there was no pathway to speak of—causing great fatigue to the camels. Quitting Mithar, we recommenced the ascent of the Wadi Ghol, and soon after a haunted glen known as Dhul Jinn was pointed out to me as being the abode of efreets and evil spirits, and which is carefully avoided after dark by the natives, who firmly believe in hobgoblins.

For four hours we toiled slowly and painfully up the steep mountain-side, strewn with fragments and boulders of light surface-coloured limestone and mottled with scanty bushes of euphorbia, until, with a final spurt and the shouts of the camel-drivers, we arrived at 11 at the summit of the pass, the aneroid barometer indicating an altitude of 3700 feet; the highest peak of Jebel al Kur, just opposite, rearing

its head apparently some 2000 feet above us. Here we halted for half an hour for rest and refreshment and to breathe the camels.

From this point we look down a small valley running south toward Adam, called by some Wadi Seifam, from a town in it of that name, by others Wadi Ali. The juncture of the spur at the head of this vale we crossed, and found ourselves on the north-west side of the Akabat al Barak; and now, for the second time, I gazed upon the little-known, wild, and unpromising plain of Al Dhahirah, the desert province of Oman. Bare and extensive, without any conspicuous feature to catch the eye or obstruct the view, it stretched away into the misty distance and offered a landscape as unattractive as it was unvaried. The descent did not prove so slow and difficult as the ascent, and we soon reached the shoulder of the mountain, a level stretch of sand and pebbles, about halfway down the slope, in which are located two shepherd hamlets, the one called Sint and the other Sunt.

Here the camels' loads were readjusted, and we made a fresh start, the road now falling into the Wadi Ain, at this elevation a rugged ravine, but further down the valley a large and seemingly important stream with running water. The direction it took was pointed out to the west-north-west, and under the name of Wadi Talaif it flows, studded with palms and villages, nearly to the sea at Abu Thabi. This river is, no doubt, the one mentioned by Edrisi noted above, as flowing into the Persian gulf at Julfar; but he was misled as to the source of it, as it rises, not at Nezwa, but in Jebel Kur. The low, sandy, maritime plain usually known as the Pirate coast, but formerly called the Julfar coast, took its name from the old Persian town of Julfar, which stood on the site of the present Ras al Khyma.

We were now able to move on at a fair pace, and at 2 p.m. came to a village called Hail, belonging to the Beni Hina tribe, situated almost at the foot of a very remarkable and, as it appeared to me, nearly perpendicular mass, perhaps 2000 feet in height, so evenly and delicately indented or notched along its ridge, that it had obtained the name of Jebel Misht, from the fancied resemblance its acicular peaks bear to the teeth of a lady's hair-comb. This comb-hill struck me as being so singular that I did not fail to take a photograph of it the following morning, though it was then at a greater distance and had lost some of its peculiarity.

Skirting the fields and cultivation of Hail, which with Jebel Misht we left on our right, we rode on for two hours more, and, just as it was getting dusk, arrived at our destination, Al Ein, a small hamlet of about 100 souls, so called from its copious spring. The sudden appearance of a mounted party, evidently well armed, threw the good people into a ferment, and in their excitement the guard in their watch-tower greeted us with a volley from their match-locks. We were so near at the time that one of the bullets grazed a

camel's leg, but no harm was done; and as such incidents were too common to be noticed, we were soon seated amicably on the bank of the nullah in the midst of the elders, who expressed regret for their precipitation. They gave me the names of the other hamlets in the ravines springing from Jebel al Kur, viz. Shedait and Nadan; but it is evidently a desolate region where the paucity of the population attests the poverty of the soil, and where the rarity of vegetation proves the scantiness of water. The only industry I could hear of at Al Ain was the manufacture of coarse pottery. The elevation of this place is 1400 feet.

After I had taken some photographs on the 24th, we mounted and resumed our journey down the Wadi Ain for some distance, and then turned off to the right over a sterile plain mottled with a few stunted acacias and euphorbias towards Bât, which we reached after 12 miles of travel. This town is inhabited by about 400 of the Beni Kelban, who cultivate wheat and indigo chiefly, and engage themselves in dyeing cloth, the dye stuff being made in large earthen jars called kabaia. We were not received here with any demonstrations of welcome, and the reason was soon apparent. It seemed that we had intruded upon a divided community, who had fallen out about a felej that irrigated their fields, and so bitter had the quarrel become that it had culminated in a permanent split, each party having constructed for itself a hujra, or walled enclosure, and having boycotted each other were now nurturing in their bosoms that implacable animosity so distinctive of local and parochial controversies. Here we halted for an hour to drink coffee, while our Kefeer Shaikh Nasir, who belonged to this tribe, interviewed the elders and busily studied the pros and cons of the dispute, in which he seemed much interested. We then proceeded on to Mohaira, where the watchmen on our approach saluted us from a distance with a desultory matchlock fire until Seyyid Hamood sent forward a man to expostulate, whereupon the recognition of friends having dispelled the cloud of anxiety, the sunshine of joy took its place, and the people, headed by their venerable shaikh, came out in procession to welcome us with noisy demonstrations, shouts, firing, and dancing. This being over, followed an invitation to pass the night there, which we agreed to do in view of the fatigue of our camels and other circumstances. The shaikh treated us cordially and lodged us comfortably. The village is small, perhaps seventy or eighty houses, but is refreshingly surrounded with plantations and orchards of dates, mangoes, limes, and plantains, etc., and the cultivation includes fields of wheat, jowari, lucerne, pulse, sugar-cane, and indigo, a bountiful stream of water sufficing to supply the whole needs of the population.

The following day we marched 8 miles on to Deriz, one of the chief towns of the Beni Ghafir tribe in this province, having a population

of about 1200. On sighting our party, the shaikh and his people came out in a very friendly way to greet us. There is a small dilapidated fort here with two guns, and I was told there were hot springs in the vicinity. After a short halt at Deriz, I rode off with some of my party to visit the fort of Al Einein, or the Two Springs, a famous bone of contention in these parts for many years past. The castle is a large and lofty but rather decayed structure, with a walled courtyard flanked and strengthened by two towers, and though looked on by the natives with much respect, it did not appear to me a very strong place.

Within a short distance of the castle there is an extensive grove of date and other fruit trees, watered by three felejes or subterranean streams, half of which belong to the Ibriyin tribe, who are strong in this district and were the former owners of Al Einein, and half to the present possessors of the castle, the Beni Ali, who receive a yearly revenue of 200 bags of dates and 100 dollars in cash for the farm of their moiety. There are no inhabitants at Al Einein now; intestine dissensions and tribal wars have driven them away, and there is but one village left in the vicinity, Irâka, which lies just behind Al Einein and belongs to the Ibriyin.

About the year 1880 the Sultan, for political reasons, transferred his alliance from the Yemen or Hinawi faction to that of the Nizar or Ghafiri faction, a move which had a very disturbing effect in the country. In Dhahireh, where the general interest had been concentrated on Boo Einein, the change brought matters to a crisis, and a struggle for the possession of that fort ensued, which ended in its passing from one faction to the other. A large number of tribes were engaged in the contest, and the general commotion was out of all proportion to the value of the stake at issue, this being quite insignificant to any party. After much heavy fighting, the fort fell into the hands of the Beni Ali tribe, a result injurious to the prestige of the Sultan, whose power and authority continued to wane until they were restored by the decisive defeat of his brother Abdul Azeez towards the end of 1883, from which time they remained paramount until his death.

Turning again to join the party, we rode past the deserted ruins of Al Ghabbi, an ancient and historic town of some extent, and here I lingered for some little time, recalling to my mind the troublous times of 1875, when the place was sacked and destroyed by the Beni Ali tribe after a siege and a sanguinary conflict.

It was about 2 p.m. when we arrived at the town of Obra, where I intended to halt, and we had hardly dismounted and been received by the shaikh, when one of the baggage-camel drivers came up and reported that he had been waylaid by robbers and looted on the road. At first we were incredulous, as none of the rest of the party had seen anything likely to excite suspicion as we came along; but on inquiry it turned out that, trusting to the fact of his being a native of Obri,

and imagining that he was safe from thieves in his own district, the driver had lagged behind with the intention of coming up slowly alone. He found, however, that he had overrated the fraternal feelings of his townsmen, and that robbers are no respecters of persons, for having been espied on his solitary ride, he had been dexterously cut off by two men, who had compelled him to unpack his load and exhibit his treasures. They relieved him of his matchlock and dagger, and took a bundle of clothes belonging to my servant, but did not touch the other articles in the load, which included among other things the photographic camera. After overhauling the pack the thieves decamped, as we heard afterwards, to a distant village, while our camel-driver, having repacked his load, had ridden post haste in to Obri.

The shaikh was greatly shamefaced at what had occurred, and, admitting himself responsible, promised full restitution; but, as I was well aware, he was quite helpless in the matter, and had no control practically over his people. Later in the day Seyyid Hamood learned that the two robbers were part of the band of seventy who had crossed into Oman on a marauding expedition, as mentioned above, and who, having just returned from there, were scattering homeward. It was refreshing to hear on the best authority that the raid had been a conspicuous failure, and that the would-be spoilers had not only gained little, but had been roughly handled into the bargain. They had, it seems, attempted a surprise on a village not far from Nezwa, and had managed to collect a few camels and women's silver ornaments before the alarm could be raised and the men summoned from their work; but the resistance had then been so stubborn that, though the villagers were in the minority, they had compelled the marauders to retire, leaving two of their number dead on the ground. Three of the villagers had been killed, and many had been wounded on both sides.

Obra is a large town subdivided into sixteen haras or sections, and is situated under a low white hill called Herbareh. The irrigation channels of the rich fruit orchards and cornfields which cover their luxuriant and well-watered oasis are supplied from two magnificent felejes leading from the adjacent hills. The date palm, whose graceful plumes are such a marked feature in Arab landscape, is here, as one may say, subordinate to the other fruits, of which Obra can boast an immense profusion and great variety. The oasis, however, will take long to recover from the effects of the great hurricane of March, 1885, which swept across it in the full tide of its fury, committing terrible havoc among the orchards, uprooting and hurling trees to the ground. Many of the best houses in the place were also demolished, including the wali's, whose residence was found to be little better than a heap of ruins. There is a small castle here with a high wind tower, and nearer to the white hill the site of a more ancient and ruined castle was pointed out to me, renowned in the land, and still fresh in men's

memories as having sustained many years back one of the most furious sieges recorded in Oman history.

No little interest is lent to the bazaar of this town by the fact that it is not only by far the largest and most frequented in Al Dhahirah, but also possesses the characteristic feature of being the "Thieves' Auction Mart," where the booty and loot annexed and collected by the highwaymen of this Alsatia are disposed of to the highest bidder. I therefore paid it a long visit, and found that, in addition to the advantage of being a thieves' bazaar, it contained shops and booths of every description, and presented a very lively appearance, all the artisans being evidently in full employment, the town comprising considerable indigenous industries and productions. The market, dirty and malodorous though it be, is thronged with spare gaunt Beduins and townsmen, all well armed, jostling each other or haggling in a loud key with negro and other sellers about the price of commodities, and presenting an animated picture of Arab life. It consists of about three or four score shops, displaying all the articles usually required by Arabs, tradesmen working at their crafts, eager, bustling, and no lack of employment, negresses in rows squatting on the ground with baskets of fruit, kabobs, cakes, sweeties, and bowls of lubia soup. The wali, Mohammed bin Abdulla al Yakibi by name, was very civil and desirous of showing attention. He escorted me all over the town, the glories and beauties of which he was resolved should not be hidden from me, and was very careful to point out the lion of the town, viz. the Jami or Great Mosque, a plain, undecorated, unimposing structure, with nothing remarkable about it whatever, but which the inhabitants are very proud of, and consider to be the largest Ibadhi mosque in Oman.

As I have said above, Obra is a famous place for fruit. Limes, mangoes, sweet limes, dates, peaches, apricots, quinces, figs, bananas, oranges, pomegranates, pomeloes, almonds, plums, guavas, citrons, melons, and others, are grown and largely exported. Obra may, indeed, be looked on as the present capital of Al Dhahirah, and contains roughly about 5000 inhabitants. Al Dhahirah means the Ultramontane province, or that which lies behind the Batineh and the range known as Al Hajar. It enjoys the worst reputation for the lawless and predatory character of its dwellers, the tribes occupying it being one and all thievish, treacherous, and turbulent, subsisting to a large extent on the produce of their raids and incursions into the Batineh and other districts. In a country where every able-bodied man is habitually well armed and ready to fight and plunder, the quantity of available rascaldom is pretty considerable, and the quality of ruffianism is quite in keeping. It is a poor, wild, and thinly populated province, and is, though I have twice visited it, less known to me than any other.

In March, 1836, Obra was visited by Wellsted and Whitelock, who

remained two days. The fact was perfectly well remembered by the people, and the spot on which their tent had been pitched was at once pointed out to me. It happened, unfortunately for them, that the time chosen for their visit was not an auspicious one, as the Wahabees were then marching through the town towards Oman, and the two officers narrowly escaped ill treatment at the hands of these fanatics, having been pelted with stones, driven out of the town, and eventually compelled to return to the coast. The elevation of Obra is 1180 feet.

As it was considered not improbable that we might meet with roving bands of Arabs on the road to Dhank, which was our next destination, Seyyid Hamood arranged with the Wali Shaikh Mohammed al Yakibi to accompany us thither, and he also took the precaution to engage one or two men of the Beni Kattab tribe as kefeers. The shaikh, however, was not ready to start when we were mounting our camels the next morning, so we set off without him, and had ridden more than halfway before he joined the party. Our course now lay due north, and soon after leaving Obra we crossed a low ridge of hills with an average height perhaps of 400 feet, the road for the rest of the way lying over a slightly undulating plain, sterile, waterless, and unadorned, save with the scantiest vegetation. Trending away at some distance on our right hand, and running parallel with our course towards the north, is the range known as Al Hajar, the intervening ground being rough and hillocky, intersected by shallow ravines. On our left, towards Bereymi, no vestige of a hill is seen to break the level line of the horizon, and the ground falls with a gentle declivity. It is a wild and little-known part, with a few villages, such as Sedaikee, Senanah, and others; but I could not afford the time to visit it.

Here we may be said to quit the margin of the Great Desert, and to turn our faces towards the inhabited regions. This wilderness, on the eastern border of which we are now standing, stretches away to the westward for about 700 miles, forming the largest and most inhospitable expanse of sandy waste on the continent of Asia. Broadly speaking, it is devoid of rivers, trees, mountains, and human habitations, unexplored and unexplorable, foodless, waterless, roadless, and shadeless, wind-swept, and a land of quietude, lethargy, and monotony, perhaps unparalleled in the world. The extent may be best described by saying that it covers an area ten times that of England and Wales. The surface of the desert is said to be generally undulating, presenting here and there low ranges of hills, with groups of green and shallow wadies or oases, usually dry, but with an outline marked by verdure. The greater part would seem to be absolutely bare. In this desert the vegetation, it may be noted, chiefly consists of euphorbias, various acacias, such as camel-thorn, sayel, ghafe and samr. Tamerisk, dwarf palms, probably a species of chamerops, oleander, senna, colocynth, the rhamnus or sidr, rak, coarse grass in tufts, the useful calotropis or silk tree, which

provides cordage and medicine, etc. The rainfall is scanty, but the Arabs make use of pools of water left after rain in the watercourses, and frequently obtain water in the ravines by digging. There are also springs of brackish water welling up here and there; the vegetation, however, obtains its chief supply of moisture from the dews, which are extremely copious in this country.

The desert is generally spoken of by the Omani Arabs as Al Jafur, or the unfrequented space, and as Al Ramool, or the sands; sometimes as Al Ahkâf, or the sandhills; also as the Sahar, or desert. In Arab geographical works it is called by the expressive name of Roba al Khali, or the empty habitation. The Bedouins, too, have of course their own names for the various districts and oases distinguished by special characteristics. The Beduin who roam the desert are mostly contingents from the tribes on the border surrounding it, and none of them, I believe, can be considered as truly nomadic. It is, however, difficult to believe that any part of the desert can be wholly inaccessible to the hardy Beduin and his friend the camel, with their wonderful power of endurance under privation of all kinds, as they can travel comfortably 60 or 70 miles a day, and carry food sufficient for several days, the scarcity of water being the one great obstacle they have to contend with.

In the eastern part of the desert the extensive tracts clothed with verdure are of great value to the people of Oman, as the Beduin who range it are able to rear vast numbers of camels, and thus perform a valuable service to their brethren dwelling in towns and villages, by providing them with an adequate supply of these useful animals. The Omani Beduins who are chiefly engaged in this pursuit are the Deru, the Aal Wahibeh, and Awamir tribes, and the sale of young camels at Adam, Obra, and other markets constitutes their chief support; they also rear large numbers of goats. The Affar Beduins, who are a section of the Awamir, are said to scour the desert more extensively than any other Omanis; they are very wild, truculent, and under no human control. They appear to live in an almost chronic state of semi-starvation. I have seen many of them and heard many stories about them. The large and powerful Jenebeh tribe, whose chief towns are Soor and Al Ashkharah, and who still possess the coast-line from Ras al Had to Dhofer, as they have done for two thousand years or more, are a seafaring race and do not rear camels. The speed and other high qualities of the Omani camel place it on a par with the famous Mahra breed, with which it is indeed identical, and which is deemed by the Arabs to be unsurpassed. That in former times attempts were made to establish caravan routes across the desert can hardly be doubted, but no efforts in this direction have been made for many years past.

In his Alte Geographie Arabiens Sprenger discusses the various routes through the desert, and mentions that in the year 616 H., 1219

A.D., some Beduins from the Neyd visited Dhofar in the time when Al Haboodhy ruled in that town, and started thence across the desert to Yemama, but never returned. The number of mammals to be found in these parts of the desert where vegetation exists does not, probably, exceed a dozen in species. The *Oryx beatrix*, known generally to the Arabs as the bakr al wahshi, or wild ox, but called by the Omanis the boosohla, is found in most parts, but is said not to approach within 50 miles of the sea-coast. There are two or three species of gazelle—one is the graceful reem, or white doe, which is rather scarce in the Omani desert; another species, the thabi, is of a rather darker colour and abound in the oasis. The wild ass, known as the himar al wahshi, inhabits the Antal and Yuba districts between Adam and Ras Madraka, and is not common elsewhere. The flesh of it is said to be more esteemed by the Arabs than that of any other game. The hydrax, or coney of scripture, has lately been discovered near Dhofar. The wolf, hyena, black hedgehog, hare, jerboa, and field rat make up the list of all the animals I could hear of.

It began to rain heavily soon after we had started, and the wind was so bitterly cold and piercing that by the time we had arrived at Mazun, a Belooch town 18 miles from Obra, we were all shivering, and I was so benumbed that I could hardly dismount. This place is inhabited exclusively by Belooches of the Hôt tribe, and contains no Arab. A large portion of the population came out to gaze at us, but their demeanour was unmistakenly unfriendly, and they did not invite us to enter the town, which I accordingly did not visit; but we lighted a big fire to warm ourselves, and those who could manage it changed their clothes, for we were drenched through. The Belooch stood around scowling at us as we remained, but were otherwise inoffensive. This was the only place I visited on this journey where I was not welcomed, for the little ebullitions of excitement that had occurred at some of the villages on the road as we passed were simply the result of fear caused by our sudden appearance, and were not due to unfriendly feeling, as was shown by the reaction that took place when they learned who we were. Mazun seemed to be a large town, with a high wall round it, but without fort, bastion, or tower that I could see. The elders told me that the Hôt had established themselves there seven generations back, perhaps about 200 years.

Turning our backs unregretfully upon the Belooch town, we pursued our journey for 8 miles further, still going north, and arrived at Dhank about 4 p.m. We found that a good many people had assembled in the open space where we had to alight, and the shaikh gave us a very friendly, though undemonstrative reception. Dhank was of much greater extent than I had expected to find it, and I was charmed with its quaint situation and beauty. The number of people is said to be about 4000, composed mainly of four tribes, viz. the Naim, Washâsha,

Azeez, and Al Boo Shamis, of which the first-named may be considered the predominant. The head shaikh and Wali of Dhank, and Shaikh Mohammed bin Ali al Naimy happened at this time to be absent at Al Beraimi, and the shaikh in charge was Khalfan bin Ali, whom I had not met before. The settlement is on the bank of a rapid stream flowing half round the base of a low transverse ridge or eminence of dark basaltic rock, which divides the town into two parts, the upper and lower, the houses being mostly interspersed among, and more than half concealed by, rich clumps of palms, orchards, and gardens. The bazaar is insignificant, and is hardly a third the size of that of Obra. The industries here are, however, most varied, though the trade appears to be less than at Obra. Besides indigo dyeing, there are several textile industries, the principal being woollen and cotton fabrics of different kinds, while bishts or camel-hair cloaks, with embroidered collars, and camel saddle-cloths are also worked here.

The castle in which Shaikh Mohammed resides is situated in Aliyya or upper Dhank, and is known as the Imam's house, built originally by the Imam Sultan bin Saif al Yaareby in the middle of the seventeenth century. Owing to the configuration of the ground, its plan is somewhat peculiar, being very long and narrow, and the curtain walls strengthened with six turrets. Some additions were made by Seyyid Azzan bin Kais in 1869, and it is now in fairly good condition.

A great deal of indigo is cultivated here, and, indeed, throughout Al Dhahireh. I was surprised at the extent of ground under it. The people showed me their dye vats, and told me that not only homespuns, but foreign imported cloths were dyed here. The house in which I was lodged was surrounded on all sides by the huts and sheds of the cloth-weavers, whose rudely constructed, creaking looms kept up an unmusical din well into the night, and this, accompanied as it was by the melancholy cry of the little booma or screech owl, in the palm grove, which latter is in Oman considered a bird of good omen, formed a concert which effectually prevented sleep. The elevation of this place is 950 feet above the sea. The Wadi Dhank is joined a little way off by the Wadi Boo Kerba, and these, flowing in a north-westerly direction, become confluent with the Wadi Safa, a large nullah in the ramool or desert pouring into the Persian gulf, nearly parallel with the Wadi Ain. These streams diminish their volume considerably in the hot season, but nature then compensates by the heavy fall of dew at night, which imperceptibly saturates the surface and quenches the thirst of the vegetation, thus reviving it and causing it to endure through a time of drought that would otherwise be fatal to it.

We had now reached the furthest point I had purposed visiting on this excursion, and as I was pressed for time, I reluctantly requested Seyyid Hamood the next morning to lead us in the direction of Mascat,

and accordingly, mounting our dromedaries, we began to ascend the narrow stony bed of the Wadi Dhank, which is densely fringed with palms, until we emerged from the gap in the rock through which it flows, and at once a pleasant change in the scenery burst abruptly upon us. The romantic and sequestered glen in which Dhank lies is sombre, the air heavy with moisture and fragrance, and the dark foliage of the trees combines with the purple rock to enhance the gloom.

After passing the gap, the wadi, we find, spreads out to a width of about half a mile, forming an open, picturesque landscape, with a fine stream of water in the middle of the bed, of which the wall-like banks rise to about 100 feet. The little plain beyond is memorable in recent history as being the battlefield that witnessed the bloodiest conflict fought between the two great rivals for the throne of Muscat, viz. Seyyid Toorky bin Saeed and Seyyid Azzan bin Kais. It was in 1869. Seyyid Azzan was at that time Imam of Muscat, having ousted his cousin, Seyyid Salim bin Thowainy, from power about a year previously, and, being thus master of considerable resources, had been able to muster an army of four thousand men. Seyyid Toorky's force was numerically much inferior, but this deficiency in strength was more than compensated by the unusually bitter hatred and spirit of revenge that had been inspired by the persecuting zeal of Azzan and his metowwa Khaleyli, who had inflicted numerous cruelties and humiliations on their religious opponents. Seyyid Toorky, moreover, though by nature less energetic, was a more wise and prudent man, and handled his troops more skilfully. On the other hand again, Azzan was in possession of a serviceable brass field-piece, which had been dragged to the spot in charge of a Persian topchi, and which added greatly to the pride and confidence of his followers. Though strong and well posted, and aided by the thunders of the one-gun battery, Azzan's force was unable to resist the impetuous and fierce attack of its despised enemy, who, rushing on with cries and shouts and wielding their double-edged swords, mowed down their foe in heaps and gave no quarter. In dire dismay Azzan's army broke and fled in confusion, the rout was soon complete, and the active pursuit added greatly to the slaughter. The loss of the vanquished was about three hundred killed. Seyyid Azzan and his priestly advisers hardly drew bridle till they reached Mascat, and he never recovered the prestige he lost in this affair. Within a year he was besieged in his capital, and was slain in a conflict outside the walls of Muttrah by his exasperated enemies. One of my party had been present in the engagement, and his description of the fight as he pointed out to me the positions of the combatants and the salient features of the battle intensified the interest of the scene.

At 4 miles from Dhank we came to the village of Dut, and 7 miles further on is Fida, whose narrow belt of palms and other fruit trees

fringes the wadi for a long distance. Both these places belong to the Beni Zeed. Between Fida and Al Einein lies a sterile, uninhabited tract, almost entirely destitute of vegetation and water. Leaving the wadi at Fida and turning to the right, we direct our course to the east, pausing at the top of the bank to catch a distant view of the picturesque town, castle, and palm grove of Yenkal, which my companions had described and were eager to point out to me. It is a populous and prosperous settlement, about 5 miles further up the same valley, and its fort is famed in Oman history as a venerable stronghold commanding one of the chief roads and passes through the mountains. I regretted not being able to visit it. At the town of Aridh, which we reached about 5 p.m. and where we halted for the night, there are numerous hot springs with curative virtues. It contains a mixed population of the Beni Shekail, Beni Omar, and Beni Kelban tribes, and is now in the possession of our guide Shaikh Nasir, like its neighbouring town Makiniyat. Both these places belonged formerly to the people of Deriz, but were captured and annexed by the Beni Kelban in 1867. The air assumed by Shaikh Nasir was one of increased dignity, and his face beamed with smiles as he welcomed us to his town, and he did the honours of hospitality with great *éclat*. The aneroid showed an elevation of 1250 feet.

On the 28th we left Aridh at 7.50 a.m., and after riding in a north-easterly direction for four hours and a half over barren, lifeless, and rather broken ground, gradually but perceptibly rising as we approached the range, we reached Maskin, a village of the Beni Kelban and a poverty-stricken place at the head of the Wadi al Kebeer, and in a notch of the watershed or crest. This chain, which divides the kingdom broadly into two parts, maintains throughout its whole length the same remarkable and characteristic features, presenting on the western or land side a more or less gentle declivity which merges into the desert, while on its eastern or seaward face it bears a wild and lofty aspect, falling abruptly in steep, precipitous crags to the mountain plain below. In the former case the valleys are shallow, verdant, and populous, in the latter their appearance is very different, being rugged, headlong torrent beds, and passing over a rough and stony passage difficult to climb and but thinly studded with hamlets, as cultivation is almost wholly precluded until the more level plain is reached. The view from this spot was really noble and extensive, and a short rest here gave me an opportunity of enjoying a landscape of a very enchanting and diversified character.

Our objective after leaving Maskin was the city of Rostak, which lies at the foot of the stupendous walls of Jebel Akhdar, and our best route would have been to follow down the winding but well-trodden bed of the Wadi Beni Ghafir, which is a natural highway, but to this our guide raised objections on account of the intertribal dissensions

then raging in the valley. Under the guidance, therefore, of two men who rode in front, we struck diagonally across the bluff brow of the mountain, and from noon to dark continued zigzagging in a generally south-east direction down the uncommonly rough and broken face, twisting and turning now down a narrow torrent bed, now along a smooth and level ledge bristling with euphorbias, calotropis, and fragrant oleander, now among crags and boulders, making slow progress, but without any serious mishap, until at a sudden bend we arrive at a clump of palms in a glen, and as these always betoken Arab habitations—for the Arab and the date do not exist separately—I determined to halt, and we were soon bivouacked round a big fire. The wretched hamlet we had stumbled on is called Mahbeh, and we found it was supplied by a copious spring gushing from the rock. Slowly as we had worked our way down the mountain-side, we had outstripped the baggage camels, which toiled painfully after, and were not brought up by their drivers for some hours. About three in the afternoon we had passed, on our right hand at some distance, the lofty peak known as Jebel Shoum, which was pointed out to me by my companion as the highest summit of Jebel Akhdar, and which certainly seemed from this spot to overtop the rest, though not by much. I now looked on it for the first time, but it was soon lost to view behind nearer summits. Shaikh Nasir informed me that Jebel Shoum rose up very abruptly above the ravine called Wadi Hajar, opposite Wadi Ein, and in this case it must stand on the north-west side of the cluster.

On the following morning we entered and descended for some hours the Wadi Beni Ghafir, in which a fine stream of water flows continuously. Then striking out of this valley, we came upon a small walled town called Dahis, with a fortlet in the centre perched on a commanding eminence. Beyond this our path falls into the Wadi Sohtan, a pleasant and fertile glen which had remained for years a cause of strife between the Beni Ghafir and the Ibriyin tribes till a few months previous to my visit, when the quarrel culminated in an outbreak of hostilities, terminating after a long and bloody conflict in the rout and expulsion of its ancient and rightful occupants, the Ibriyin. The valley was still in a somewhat disturbed and unsettled state, as no man could be seen that was not fully armed and with lighted match, but we passed through the Beni Ghafir villages unchallenged and unopposed, though without the usual friendly demonstrations of welcome. I was told that the Wadi Sohtan joined the Wadi Rostak to the north-west of that town. After further winding among a labyrinth of low dark hills, we entered the outskirts of the city of Rostak, and, dismounting in the square space in front of the chief house, were cordially and frankly welcomed by Seyyid Hamood bin Azzan, and I was assigned a lodging in a handsome stone sablah just opposite Seyyid Hamood's house. But before taking possession

of our quarters we all sat down, as in duty bound, in Seyyid Hamood's gateway to partake of coffee and exchange the news, I for one being very glad indeed to be off my camel and to get a rest after our tedious journey from Aridh; and while we were conversing up came Seyyid Saood, the second son of the late Imam Seyyid Azzan bin Kais, and of course every one present jumped up to receive him. He was soon seated amongst us, and his face plainly betokened the pleased surprise he felt at seeing so large a party of strangers in the gateway. Indeed, Seyyid Hamood and others had been equally astonished at seeing us, as they remarked that their latest news of our movements reported us to be still beyond the mountain range. Saood seemed to be a fair, bright, and handsome youth of about eighteen years, and of pleasing, dignified manners. He had, since his father's death in 1870, been with his elder brother Hamood, under the care of his paternal uncle Ibrahim, who usually resides at Rostak, but who happened to be at this moment absent at the fortress of El Hazam in the Batineh. I reckon Rostak to be the third largest town in Oman, Mascat being the first, and Semail the second. It holds fifteen villages in fief, and with these the population is estimated at 14,000. The bazaar is substantially and regularly built, and contains eighty shops with every description of merchandise for sale. In more than one of them I saw trays of fried locusts.

Rostak is a place of great salubrity, and is famous for its cool and temperate climate. Fanned as it is by the sea-breeze on one side, and sheltered from the scorching blasts of the great desert by the noble mountain which towers so majestically and precipitously on its south-west side, the air is dry and mild, and it would, like Nakhl, make an excellent sanatorium for Mascat. It owes much of its reputation, however, to its thermal springs, of which it possesses two very copious ones, ranking among the hottest in Oman. We passed them as we rode into the town, and saw that they were both enclosed in large circular tanks or reservoirs. They are much resorted to by the people, who have great faith in their medicinal virtues. The waters contain in solution a good deal of calcareous matter, and it is astonishing how many use them both internally and for ablution. Being close together, they probably derive their origin from the same source or fountain, and find their way through the fissures or dislocations of the rock.

I saw here vines, papayas, guavas, and mangoes, etc. Lucerne, wheat, millet, maize, and barley are grown, besides maseybili, lubia or Egyptian beans, bakili and other legumens, pulses, and vegetables of several different kinds.

Concerning the mango, I may here quote a curious observation of an old traveller, Mr. Parsons, who in his 'Travels in Asia,' p. 210, says, "This (August) is the season in which mangoes are ripe, which are so very excellent in their kind as to be preferred to any from India.

The stones of the Mascat mangoes are an acceptable present to those gentlemen in India who have gardens large enough to allow room for their growth. We bought a thousand mangoes for two rupees (five shillings), and endeavoured to preserve some of the largest to present to our friends in Bombay; but they would not keep sound during the few days we remained here. We picked out the largest of the stones, which Captain Farmer and myself divided between us."

How the Mascat mango came to be so much appreciated by the English at Bombay is a mystery, as it is rather coarse and stringy, and is far inferior to the Bombay variety, which was brought to perfection by the Portuguese, and is the best in existence. Mr. Parsons was a passenger in H.M.S. frigate *Seahorse*, which was lying in Mascat harbour in August, 1775, and one of whose officers, at that time a midshipman, was the great Horatio Nelson.

The general appearance of Rostak is superior to that of other Oman towns, and struck me as very fine and attractive, with its large white mansions, its venerable castle, its handsome though undecorated mosques, all embedded in magnificent plantations of shady mango, date, plantains, and orchards of fruit trees, backed by the frowning cliffs and crags of the grand cluster of Jebel Akhdar rising tier on tier above it. Traces of the great hurricane were everywhere visible in the town, and the upper story of Seyyid Hamood bin Azzan's house, a large and substantial stone structure, of which I took a photograph, bore evidences of the rough treatment it had experienced at the time.

The castle is a large and imposing structure said to be of great antiquity. It stands at some little distance from the town, but not, as is usually the case, on an elevated or commanding position. I gazed with considerable interest on this time-worn pile, which, though rather dilapidated, had the reputation of great strength among the Arabs, and is perhaps the oldest inhabited building in this part of Arabia. Within a large courtyard, the angles of which are strengthened with bastions, stands the keep or citadel, consisting of a body with four turrets. One of these, called the Burj al Rih or Wind tower, was built by one of the Yaarebeh princes, another turret was built by the Imam Ahmed bin Saeed when he established his residence here about 1750 A.D. The most ancient part of this stronghold, which bears a close resemblance to an old Anglo-Norman castle, is probably that part with its turret known as Burj Kesra ibn Shirwan, and the erection of which is ascribed to the period of the great Sassanian monarch Noushirwan, or, as some say, Khosru Parviz, in whose reign the famous expedition about 600 A.D. to expel the Abyssinians from the Yemen was undertaken.

The command of this expedition was entrusted to a Persian noble named Khuzrad Narsis, generally known by his title Wahraz, who, on his way down the Persian gulf from Obolla, detached a force of four thousand men, probably about one-fifth of his whole army, to invade

and occupy Oman. The Persians landed at Sohar, and were so far successful that they were able to subdue the Batineh coast as far as Rostak, where they remained for about thirty years until the advent of the Moslem troops under Ikrima and Hodhaifa compelled them to evacuate the country.

The erection of the castle is due, according to Arab tradition, to the governor left in Oman by Wahraz. Its appearance is imposing and its structure substantial, and with successive repairs has remained for many centuries. Castles or fortlets similar to that at Rostak, of which there are about twenty in Oman, form the military and political centre of a province, and were built to overawe as well as protect the surrounding country. In domestic and intestine wars, whether tribal or dynastic, as well as against foreign aggression, they have played a very important part, and many a long and vigorous siege has become memorable in the annals of the country. The castle had generally a walled enclosure with or without mural towers, and the plan of the work was, of course, greatly influenced and affected by the disposition of the ground. Flanking towers or bastions are sometimes found, but the secondary defences are seldom strong. The concentric system is said to be of Arab origin, and was used in England after the Crusades.

The appellation of Rostak signified a market town, and we conjecture that the Persians were attracted to it, not only by the hot springs, but also by its central position as a meeting-place or market for the Arabs. The headquarters of the Persian Government were, according to Ross's 'Annals of Oman,' near the great port of Sohar, but it is locally traditioned that this castle of Rostak was ordered to be built by the king, who caused an iron chain to be suspended therein connected in some mysterious way with his palace at Ctesiphon. Any of his Arab subjects who had reason to complain of injustice or oppression were at liberty to come to the fort and shake the chain, the immediate consequence of which was investigation and severe punishment of the offender by Noushirwan.

Rostak has always been a place of political importance, and it was for a long time the capital of Oman, but it was in the seventeenth century, in the days of the Yaarebeh sultans, that it reached its climax of power. The founder of the Al Boo Saeedi dynasty, which succeeded, retained it as the capital until the end of the eighteenth century, when Mascat took its place. Since then it has been the appanage of the Kais branch of the family, and is now in the possession of Seyyid Ibrahim bin Kais, who has made more than one attempt to imitate the example of his brother Azzan and wrest the sovereignty of Oman from the present branch. At Adam the house in which the Imam Ahmed bin Said was born had been shown me, and here at Rostak, where he died in 1783 after a reign of over forty years, I saw his tomb. It bore a long inscription, of which I obtained a

transcript, in which the date of the Imam's death is given, according to the Mohammedan calendar, as 19th of Muharram 1198 H.

Though the wadi in which the town stands is here called Wadi Rostak, it is known as the Wadi Auf higher up, from a small tribe of that name occupying the ravine and claiming to be originally from the Hejaz. Lower down, I was told, it is called the Wadi Fareh. Rostak is 800 feet above the sea. From this direction Jebel Akhdar appeared to be a tabular range without any salient peaks. The bluff point marked on the chart, and the altitude of which is given at 9900 feet, cannot be the same as Jebel Shoum, as the latter is said to be invisible from the sea. It has an angle of 270 from Rostak. The formation of the rock-masses here is very similar to that of Nakhl, and is no doubt metamorphic, the wavy appearance of the sedimentary rocks exhibiting the power of lateral pressure or of the oscillation of the Earth's crust during the time it was in a fluid condition. The hot springs, it may be added, are without taste or odour, but leave a slight deposit. The cold springs, which are also abundant and which help to supply the town and irrigation conduits, are of the temperature of the ground, and have a different origin from the thermal ones.

Rostak is distant about 90 miles from Mascat, and as the time I had allowed myself was getting short, I determined to ride there in two days, as the camels were still fresh and in good spirits. On the morning of departure, therefore, after taking some photos of the castle, we started off; but as none of us were acquainted with the road, we travelled for a considerable distance on the way to Sowaik, until we were put right by some villagers. At 11 a.m. we reached Mansoora, and soon after passed a small square town on a hill. At 1 p.m. we arrived at Jemma, a large village with a tower and castle, the latter standing on an eminence. Here we stopped an hour for rest and refreshment, while I seized the opportunity to look at the castle, which has an historical interest of its own. It was in 1807 that Seyyid Bedr bin Saif, who had usurped power with the aid of the Wahabees on the death of Seyyid Sultan three years before, was at Jemma with the two sons of Sultan—Salim and Saeed. Instigated and encouraged by others, Saeed took advantage of an unguarded moment to stab Seyyid Bedr, who, being alone and unsupported by his dependents, leaped from the window and tried to escape, but was pursued and killed. Seyyid Saeed rode at once to Mascat and seized the throne, which he retained till his death in 1856.

The ground from Rostak to Barkah, which we reached at sunset, has a gentle declivity, and our camels sped over the sandy soil at a rapid pace, being conscious, no doubt, that they were homeward bound. The distance is about 45 miles. Mascat, which is about the same distance, was reached the next evening, December 31.

THE YOLA-CROSS RIVER BOUNDARY COMMISSION, SOUTHERN NIGERIA.*

By Major G. F. A. WHITLOCK, R.E.

The British Commission left England on August 17, 1907, for Yola, in Northern Nigeria, for the purpose of delimitating, in conjunction with a German Commission, the boundary between Nigeria and the Cameroons from Yola to the Cross river. The members of the British Commission were myself, with Captain Moore, R.E., Lieut. Nugent, R.A., and Lieut. Downes, Royal Sussex Regiment, as assistant commissioners, Dr. Beale Browne, of the W.A.M.S., was the medical officer, and two non-commissioned officers of the Royal Engineers were attached. For the first year the German Commissioner was Major Haering, with Oberleutnants Von Stephani, Cuno, and Rothe as assistant commissioners. Oberleutnant Von Stephani then took over this duty, and his staff was augmented by Oberleutnant Bartsch. The British Commission were delayed for a short time at Lokoja, owing to transport not being available, but the river Benue being in flood, they were able to make the journey to Yola in a steamer, where they arrived on September 26, 1907.

The boundary-line south of Yola approximately follows the circumference of a circle whose radius is 29 miles, and it was at the point where this circle cuts the line joining the centre of Yola with the centre of the Cross river rapids that the work of the Commission started. The boundary-line runs generally in a south-westerly direction to the Cross river, and is about 320 miles in length.

The Commission, having been supplied with carriers by the Resident, left Yola on October 6, 1907, for Gijaro, a hill near the starting-point of the boundary-line, which was reached the following day. Here the first headquarters were established.

The point near Bayare, south-west of Yola, from which the boundary line between Yola and the Cross river starts, is situated in an undulating plain which averages 1400 feet above sea-level. Rivers and streams traverse this plain in a northerly and north-westerly direction, eventually uniting and flowing through flat country, in which rise a few isolated hills, into the river Benue. The plain is covered with thin bush, and is dotted with villages, the inhabitants of which grow guinea corn in large quantities. There are no roads, but bush-paths exist between the various villages and farms. The distance between places connected by bush-paths is, as a rule, half that actually traversed, as it appears to be the custom of the natives never to remove a fallen tree or obstacle, but to at once proceed to make a path round it. As the smaller villages are always changing their names, and often their sites, it is sometimes difficult to get reliable information concerning them, and new guides have to be obtained at frequent intervals.

* Read at the Royal Geographical Society, June 6, 1910. At the same meeting a paper on the Land of the Ekoi was read by Mr. P. A. Talbot. The discussion will be appended to Mr. Talbot's notes. Map, p. 512.

The most prominent point in the plain through which the line runs is the rocky peak of Lamja, a solitary pear-shaped mountain 3500 feet above sea-level, the top of which is covered with huge boulders and is almost inaccessible. A beacon was fixed on the highest rock, whose northern face has a sheer drop of several hundred feet. The hill is covered with pagan villages, the huts, which have the appearance of large beehives, being perched on the rocks and in the interstices. The following remarks of a member of the Commission will give an idea of the difficulties of ascending and observing from the top of Lamja: "As a feat of mountaineering, the placing of a beacon on the top of Lamja has its merits, but for practical purposes the difficulties of observing on a solitary rock 6 feet square with a precipitous drop on one side of about 1000 feet are many, while the risks in transporting theodolites, etc., up places where one has to be hauled up 10 feet at a time are very great."

At the southern edge of the plain, which is about 20 miles south-west of Bayare, there is a narrow valley penned in by hills, in which the upper M'Bulo river flows. From the top of this valley the ground rises abruptly, until it meets a ridge of the Shebshi mountains (the Basalt plateau), which runs north-west and south-east, and is the watershed of the rivers M'Bulo and Kam. On this ridge are several conical peaks, from any of which a magnificent view can be obtained. On every side, extending as far as the eye can see, are tumbled masses of mountains with small plateaux cut up by deep valleys and rocky fissures. Looking south-west along the boundary, the valley of the river Kam appears to be the only outlet from the hills. In this valley, at the foot of a big mountain called Vorsen's peak, lies the small village of Gankita, and near here several torrential streams unite, forming the headwaters of the river Kam. This river in its early stages runs between two great blocks of mountains, those on its left bank culminating in Vogel Spitz (6700 feet above sea-level), which was the highest point in the vicinity of the boundary-line. From this mountain there runs a large stream which flows into the Kam, near three finger-like pinnacles of rock. An attempt was made to climb Vogel Spitz by way of this stream, which runs along the bottom of a very narrow, deep, and winding gorge, but it was found quite impossible owing to the high and numerous waterfalls.

Throughout these mountains and their foothills the country is so rough as to be ill-suited for cultivation. The Chambas, who live on the hills, grow a certain amount of guinea corn near their villages, but they have their chief farms in the valleys.

The track from the M'Bulo valley to that of the Kam is difficult for horses, being very rough and circuitous. It ascends to nearly 5000 feet above sea-level when traversing the Basalt plateau. The river Kam runs in a south-westerly direction, and at Ganteni leaves

the high mountains, flowing through a plain about 20 square miles in extent, where it is joined by several streams from the east. The hills on both banks now become much lower and close in again, forming a narrow gorge at Gani through which the river flows. About 10 miles west of Gani is a prominent hill called Yunkussum. Near Gani the Kam leaves the boundary-line and flows alternately west-south-west and west-north-west in parallel reaches with rocky wooded hills on both banks. The river itself is practically inaccessible, except at regular crossings, owing to the dense thicket and long grass growing along its banks. The bed is alternately rocky and sandy. Good-sized fish are caught near Yunkussum. Villages are scarce in this part of the country, averaging about 5 miles apart. It then flows westward, and reaches a point 30 miles on the British side of the line, whence it turns south, meeting the big river Teraba at Bakundi, a large town inhabited by Fulanis and Jukums or Dinyis. There is a mud wall round this town which is in a very bad state of repair. Here also the Niger Company have a small store. Near its junction with the Teraba it flows through a series of lagoons and swamps. This country is thickly populated, the farms mostly belonging to Bakundi.

South-west of Gani are more high hills, through which the line passes for a distance of about 30 miles. In them rise many small streams which run westward to the Kam, through a plain dotted with hills. The courses of these smaller streams are marked by fringes of thick dark trees, or "curmi." Throughout this country, after the annual grass-burning, may be seen many herds of antelope.

The line now runs through the country enclosed by the rivers Kam and Teraba, which is a vast level plain 500 square miles in extent and covered with bush. There are only a few isolated hills in this plain, the most prominent being Maifula. This is a tower of rock which rises 1000 feet from the surrounding country, and has a large village at its foot. At Dunkussum and Maduri there are several high hills in the neighbourhood of the line, while to the south is the so-called Gongome forest. The bush is thick here, and there are large belts of trees which can only be crossed by the worn paths through them, while one meets in the middle of these belts villages which are surrounded by big stockades. The river Teraba now crosses the line. It is some 600 yards wide, with a sandy bed, and flows north-east past Bakundi into the river Benue. It is fordable in the dry season, while in the rains steamers come up as far as Bakundi. The largest village on it near the line is Beli on its left bank (British). There are a large number of small farms in this part of the country.

A few miles from Beli is a high, solitary mountain (Hoshere Kun) covered with boulders. This is the finest natural feature on the line. It rises abruptly from the plain, which is 800 feet above the sea-level, to a height of 4374 feet. This peak took seven hours to climb, two

hours being spent in getting on to the highest rock of the gigantic pile which forms the summit. From this point one sees the whole of the large plain to the north, and the river Teraba appears like a broad silver band, quite 50 miles of it being visible. To the east, south, and west are seen high mountain ranges with no apparent way through them. There is a main road or track through the mountains on the south-east near Abashirshir. Through the plain at the foot of Hoshere Kun the river Gazabu flows from Abashirshir gorge north-east and then northward into the Teraba. Next comes a tract of country which in the neighbourhood of the boundary-line is almost impassable. A double wall of mountains encloses a kind of plateau, some 200 square miles in extent, the whole forming a solid block which projects from the Cameroons into Northern Nigeria. Through this country it was impossible to take a carrier column, but it was penetrated from several points with a view to sketching the detail. The river Suntai rises here, and its roaring waters, rushing through deep, worn channels of rock, may be heard from the tops of the many surrounding peaks. Between Abakun, a small peak on the northern side, and Damia, a village on its southern slope, there are no villages, or tracks fit for carriers, the only practicable road being by way of the Kungana pass, a big *détour* to the west.

The river Suntai debouches from the mountains near Kwossa, the district round which is fairly thickly populated. From this side it is possible to penetrate into the mountains for a distance of about 10 miles, where some curious walled villages on the tops of precipitous rocks are met with. By climbing to any of the numerous high points near here, one can just see the top of Kun over the intervening ranges. At Kwossa is a curious prominent rock, by name Nukko, which faces the gorge through which the river Suntai leaves the mountains. Work was suspended in April, 1908, at Kwossa, owing to the rainy season having set in. Five or six miles south is the village of Damia, close to the boundary, and from a high point on the plateau above this village one can see 30 miles forward down the line. The hill villages on the edges of this plateau are extremely picturesque, being built on projecting spurs; the spaces between the hive-like huts being filled by little plots of cultivation, which contain plantains, tobacco, and occasional palm trees. All the guinea corn is grown in the plain below. Looking to the east from this high point one sees a strange succession of sharp peaks of rocks, which have the appearance of the teeth of a broken comb. Looking to the south-west along the line, the country is a vast plain with two high mountain blocks on the British side. This plain is covered with thick bush, and there are a few small isolated hills on it. In places there are narrow belts of trees, some of which, being 150 feet high, appear to indicate high ground, whereas in reality they mark depressions or streams. Midway across the plain flows the river Donga

in a westerly direction. This river, which is here about 200 yards wide, is deep and rapid in the rainy season. It is crossed by canoes at the town of Gidan Sama, near the boundary, and also lower down at the village of Tissa.

A few miles south-west of Gidan Sama is an isolated mountain called Gargai on which are three villages, the two on the summit being on the British side of the line. From this hill the view north-east over the plain is extensive, and looking to the south-west may be seen range after range of high hills. Near the foot of Gargai hill runs the main road from Gidan Sama to Takum. South-west of Gargai, the Wanya mountains form the western extremity of a very big group in the Cameroons. They are about 5 miles wide where the boundary-line crosses them, and are covered with long grass. There are no villages in these hills, and the country is very wild.

The next plain met with is not very level; the surface is much rougher and the tracks much worse than any of those to be found to the north. The river Gamana crosses it from east to west, and there is very little cultivation, while villages are scarce. Two roads from Toso (a rubber-collecting centre in the Cameroons) to Takum (the largest town in this part of the country) meet near Lissam, a picturesque group of villages among low hills covered with oil-palm trees. Two miles from Lissam is a mountain called Kunabai, on the top of which are numerous villages reached by well-worn paths up the mountain-side, passing along rocky ledges and under huge boulders. The inhabitants are Zumperi pagans.

About 5 miles south of the Gamana river there is a mass of mountains called Zumperi, consisting of four or five parallel ranges running east and west, and extending as far south as the Katsena river. The inhabitants live on the hills, and are said to be cannibals. They grow just enough guinea corn and cotton for their own wants. They also grow large quantities of tobacco on the hilltops and slopes, supplying Takum market through the Hausa traders. This country is exceedingly rough, and quite impracticable for horses. There are few tracks, and to make a journey of only 4 miles often takes a day, owing to the precipitous nature of the country. On nearing the Katsena river the mountains become still higher, and are practically uninhabited. The tops are bare rock or covered with high grass. The circuitous track through this country to the Katsena passes over almost every kind of natural obstacle, including almost vertical slabs of rock on which it is necessary to walk sideways supported by ropes.

The valley of the Katsena is cultivated on both sides, the farms belonging to Chittan Gida and N'Gadi (British). Remains of old walls across the narrowest part of the valley point to there having once been a large settlement here. The Katsena river, though narrow at the point of crossing by the line, is very swift, and brings down a lot of

THE BUSH IN THE SONKWALA VALLEY.

BASSAS IN SONKWALA VALLEY.

SERAKI HAUSA, WITH ALL HIS JU JUS HUNG ROUND HIM TO SAVE HIM FROM THE MUNCHI'S POISONED ARROWS.

DAMIA.

water from the mountains to the eastward in the Cameroons. Rocks, however, prevent navigation. There are canoes at all the big villages on its banks. A big block of mountains on the south bank (German side) have some curiously jagged spurs resembling gigantic needles of rock.

South of the Katsena the country is much split up by long parallel chains of mountains, which cross the boundary-line diagonally, and have large rivers in the valleys between them. Of these the river Imba is the largest. Rising far in the Cameroons it flows through a wild rocky gorge many miles long, and finally empties itself into the Katsena at N'Gadi, a few miles in British territory. Even in the dry season this river is difficult to cross high up owing to rapids and the dense "curmi" along its banks. There are scarcely any villages in this valley, and none at all in the next—that of the Tunga river. The existing tracks are little used to-day, except by hunters and a few traders. Owing to the vast quantity of small streams the vegetation is rank and appears abnormal in these valleys, the thorns, perhaps, being the worst obstacle. There is practically no cultivation until the Agara district is reached. Here the mountains end, and the country opens out into an extensive tract, wherein are numerous small hills with grass-covered slopes and valleys. This country is thickly populated; the numerous compounds are, however, so scattered and cunningly concealed that they are only visible from the more commanding hilltops. Each compound has its patch of cultivation, growing small quantities of yams, millet, and plantains. There is a large tract of uninhabited country on both banks of the river Mokamon or N'Kwan, where elephant tracks are very numerous. This district is known to the hunters as Kasimbila.

Iron abounds in the small hills, which do not appear to hold water, and thus large streams rise among them. In January the trees along the banks of the Maquari and Morno rivers are a brilliant red colour. Large fish come up in the rains and remain in the pools during the dry season.

There are no very prominent natural features in this country until the watershed between the Katsena and Cross rivers is reached. This is an unbroken line of high mountains, on top of which is a grass-covered plateau which extends for miles to the west and east, and is about 5000 feet above sea-level. The outlook northward from this plateau is generally open, but great banks of cloud on the south side obscure the Cross river valley for a great part of the year. While north of the plateau the country is chiefly bush, the southern slopes and the plain extending from them to the Cross river are covered with dense forest, the trees being over 100 feet high in places. In this forest ebony, mahogany, and vine rubber are found in large quantities but the present lack of facilities of transport makes the two former of

little marketable value. Villages are scarce, the inhabitants in the few met with making small clearings in the forest with much labour in which they grow plantains. From this plateau issue numerous small streams which run into the Cross river. These streams become unfordable in the rains, being swelled by mountain torrents.

There is no road between the Katsena river and Bashu that is practicable for carriers near the line, but there is a very good one *viâ* Kasimbila, Sonkwala valley, Umbagi and Akongo, which has been recently cleared by the natives living near it, and this will, without doubt, in the future become part of the main trade route from the Benue to the Cross river. The Sonkwala valley, with its estimated population of seven thousand, is very rich in oil-palms, and the natives grow very large numbers of yams.

North of the Shebshi mountains tracks of bush cow, kob, gazelle, and duiker were met, while on the Shebshis leopard and bush cow were numerous. The valleys of the Kam and Teraba were full of W.A. and Senegal hartebeest, water-buck, kob, roan antelope, oribi, harness antelope, reedbuck, wart-hog, and various monkeys (including Colobus monkey in places); while south of the Teraba tracks of elephant and lion were met with. South-west of Kwossa there were no roan antelope, but tracks of elephant became more frequent. South of the Katsena the wart-hog appears to be replaced by the red forest pig, while elephant tracks were numerous. South-west of Matazo, the Munchis have apparently killed down most of the antelope. A few kob, duiker, water-buck and harness antelope were seen, also numerous tracks of elephant and bush cow. On the watershed plateau there are only bush cow, harness antelope, duiker, and the large forest pig. South of the watershed elephant were said to be numerous, also gorilla and bush cow, while dog-faced apes and flying squirrels inhabited the large trees. Hippos were numerous in the Teraba and Katsena rivers.

Geological specimens were collected during the tour by Lieut. Downes, and they were submitted to Dr. Teall, Director of the Geological Survey of Great Britain. The results show that the rocks in the neighbourhood of the boundary are entirely crystalline and igneous. No specimens of Cretaceous or Tertiary rocks, which are known to have a large development in the lower portions of Southern Nigeria and the Cameroons, were collected; hence it is probable that igneous and metamorphic rocks make up the greater part of the interior along the boundary-line, but some of the numerous plains traversed may be composed of soft Cretaceous rocks buried under a surface accumulation of laterite. North of the block of mountains which forms the watershed of the Niger and Cross rivers the country is covered for the most part with low bush and high grass, except near Gongome, where one finds great belts of forest which grow to a height of 150 feet, many of them being covered with orchids. On descending into the basin of the Cross

river the whole flora changes. As one proceeds up the north slopes of the watershed, the trees gradually disappear and long grass only grows, getting shorter, till at the top it is only 2 feet and often less. As soon as the southern slopes are reached an unbroken forest meets the eye, the trees growing almost up to the edge of the plateau on its southern side. With this change of flora the food-stuffs naturally alter. On the north side guinea corn is grown almost to the foot of the plateau, as well as yams, and the former is the staple diet of the natives as far north as Lake Chad. South of the watershed no more guinea corn is seen, the natives living entirely on yams and plantains.

As far south as the foothills of the Shebshi mountains the inhabitants are Fulanis, with a good sprinkling of Hausa traders. In the Shebshi mountains and valleys, and also along the boundary-line as far south as 7° 45′ N. lat. are Chamba pagans, with a few scattered villages occupied by Fulanis, and one or two towns (*e.g.* Bakundi) by Jukums.

The Chambas wear but little clothing, that of the women consisting of leaves. The inhabitants on the east spurs of the Shebshi mountains are Momyes. The villages from lat. 7° 45′ to lat. 7° 15′ are inhabited by Kentus. Thence as far south as lat. 7° 0′ Dinyis are met with. Zumperis occupy the villages in the hills between here and the Katsena river. They are reported to be cannibals, but the parties who visited their villages found no actual proof.

South of the Katsena, in the neighbourhood of the boundary, the country is inhabited by Munchis. On the plateau we find Bachots, or Bachebes, while south of it the villages are inhabited by Anyangs and Bokis, the latter occupying Bashu, the place furthest south visited by the Commission. Neither the Bokis nor the Anyangs are overburdened with clothes.

The whole of the food for the members of the Commission, in addition to the necessary instruments and stores, had to be taken with them, and for this purpose a large number of carriers were necessary, the average number during the whole of the tour being three hundred. These carriers were also employed in cutting roads, clearing tops of hills, etc., for beacons, and preparing the latter. The carriers were divided into gangs of about twenty under a headman, and each officer had two gangs with him as well as a small escort. The ordinary ration of a carrier is 2½ lbs. of guinea corn, or gari as it is called, *per diem*, with an occasional issue of meat, and as there were at one time 120 soldiers in the escort, with their own carriers in addition, half a ton of gari, or its equivalent in yams, was required every day. All the guinea corn is ground by hand by the women. For this reason it was generally not possible to have the headquarters actually on the line of the boundary, as the food question always had to be considered. Thanks, however, to the great assistance rendered to the Commission by the different

residents, the carriers were never for one day without food, although it occasionally happened that they could not be given their full ration.

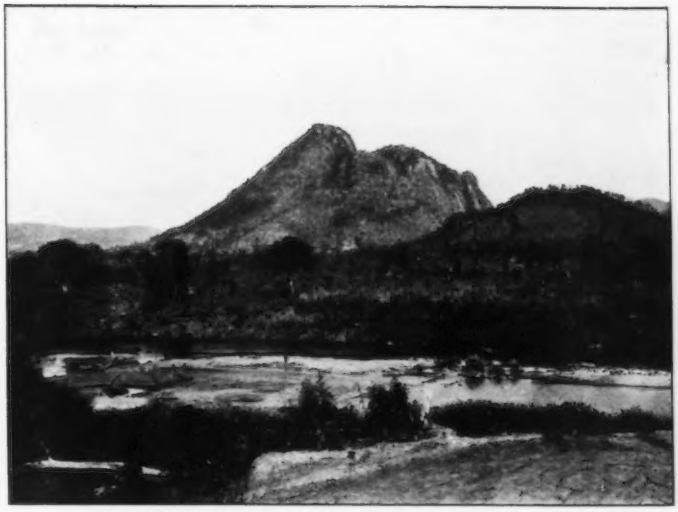
All the food taken from the natives was at once paid for either in money, or, in the case of the pagans, in cloth or salt. At the various headquarters Hausa traders opened markets, and thus the value of money began to be appreciated by the natives. The Munchis were very good in supplying food for the carriers; they would at first only take beads, salt, or cloth in exchange, but they soon also began to prefer money.

An escort was attached to the Commission during its work; at first it consisted of only twenty rank and file, but it was afterwards increased to one officer, sixty rank and file of the Northern Nigeria Regiment. On reaching Beli, this detachment was relieved by a company of the Southern Nigeria Regiment, 101 strong, under the command of Captain Jones, with two white officers and a non-commissioned officer. They remained with the Commission until it left Ibi at the end of April, 1908, to recess during the rainy season.

On the return of the Commission they were met early in October at Donga by a company of the Southern Nigeria Regiment under Captain Heathcote, with Lieuts. Homan and Hickes, and two white non-commissioned officers. They had with them Dr. Beatty, our new doctor, who relieved Dr. Beale Browne. The escort marched as near the boundary-line as possible from Ikom through country hitherto unknown, and reported that they had met with opposition at Sonkwala, otherwise all the natives were friendly. They had, however, experienced a very bad time, as, owing to the abnormal wet season of 1908, the small streams had become torrents, and the country was for the most part under water, while at times they were greatly delayed by lack of proper material for bridging the large rivers they had to cross when no canoes were available.

The attitude of the natives was friendly to the Commission throughout, except in the Sonkwala valley. This valley is inhabited by Bassas, who are cannibals. Having decided to move the headquarters early in December, 1908, to Sonkwala, as being the only known place near the line between Kasimbila and Bashu, Lieut. Homan with two white N.C.O.'s, Colour-Sergts. Phillips and King, and a strong escort was sent with carriers and advance loads to find a suitable site for the camp.

The day after his arrival when carrying out his instructions he was attacked by the natives, who were all armed with Dane guns, and had to retire on his own camp, losing one soldier, while during his absence the natives had also attempted to rush his camp but had been beaten off. He at once sent Colour-Sergt. Phillips with an escort to headquarters at Takum, a distance by bush track of nearly 100 miles, to report the circumstances, meanwhile entrenching himself against further attack. This journey was made in two and a quarter days.



VIEW FROM THE CAMP AT KWOSSA.

ON THE MARCH. "GIJARO" FROM THE SOUTH.

OUR LAST BEACON NEAR BASHU, APRIL, 1909.

VIEW FROM THE TOP OF GARUM. TYPICAL VIEW OF THE BUSH.

Fortunately, at this time Oberleutnant Von Stephani, who had taken over the duties of German Commissioner, was expected at my camp, so, knowing that the inhabitants of the Sonkwala valley numbered 2500 men, and that it was doubtful how far the hostility had spread, I asked him if he would assist us. This he readily consented to do, and I was therefore able to send Captain Heathcote at once with all available soldiers to the valley, while I proceeded on the following day with Oberleutnant Von Stephani, picking up the members of the Commission *en route*. The Germans had two white N.C.O.'s, forty rank and file, and a machine gun, and the reason of our delay was that the latter had to be sent for. Throughout our last day's march our movements in the country governed by a powerful chief called Maitumbi (the fat man) were watched by natives armed with Dane guns at approximately every 100 paces, while during a halt we were surrounded, and it can have only been the presence of so many white men which prevented their attacking us. On our arrival near Sonkwala valley we were relieved to find that Lieut. Homan and Colour-Sergt. King were safe. It was reported however that, anticipating our arrival, the natives had blocked and staked all the tracks in this valley. After consulting with Captain Heathcote, I decided to attempt to clear the valley on the following day, Christmas Eve, 1908, and accordingly two columns moved along it, one under Captain Heathcote on the right, and the other under Oberleutnant Von Stephani with Captain Moore, R.E., on the left; all the other troops moving in the adjacent valley to Lieut. Homan's camp, on a foothill overlooking the valley, so as to form a third column and reserves.

Our attack was successful; but near a village called Bika, on the east side of the valley and opposite Homan's camp, the natives, having been driven out by Heathcote's column while retreating up the side of the hills, met Stephani's column and offered a most stubborn resistance, at one time surrounding them in a yam patch. The German Maxim gun was promptly brought into action, and the situation was relieved, but, unfortunately, Stephani was dangerously wounded, being hit in the right side and arm, while of his two non-commissioned officers one was shot through the wrist and the other grazed on the arm with slugs from the Dane guns. Captain Moore during this time rendered invaluable service.

Camp was reached by this column at 4 p.m., with no further mishap, but the other column did not arrive till 10 p.m., getting bushed. On the following day, Christmas Day, slight skirmishes took place, while we were reinforced by another section with a Maxim gun from Ikom. In spite of our troubles we were all able to enjoy our Christmas fare, and were pleased to get Stephani to join us for a short time after dinner. The following day Bika and the surrounding villages were attacked, the natives not making much resistance, and a couple of

Maxim guns being brought into action at about 5000 feet above sea-level completed the rout. This put an end to the actual resistance. The chiefs during the following days began to come in and say they had had enough, while Maitumbi, who evidently had been awaiting results, sent in to say he wanted to be friendly, and that as an earnest of his good intentions he was clearing the road through his country and repairing the bridges. This he has since done. Our losses were five killed and nineteen wounded.

There is no doubt that prompt action prevented the hostility to the white man spreading, and the success of the operations was in no small degree due to the assistance of Oberleutnant Von Stephani and the German soldiers. The net result of the fighting is that a good trade road is now open between the Benue and Cross rivers, while the work of the Commission was not again delayed.

The atmospheric conditions of Northern and Southern Nigeria are a very great handicap to quick survey work, as during the dry season the harmattan continually obscures the view, making it impossible for an observer to see more than a mile in any direction. This harmattan, which takes the form of a thick mist, is supposed to be formed by small particles of sand held in suspension being blown from the Sahara, but as we got further south it was noticed that the harmattan very often came on quite suddenly in the absence of any wind at all, and it seems possible that the bush fires which occur during the dry season may, to a large extent, account for this mist. While in the north near Lake Chad, one's boxes get covered with fine red sand during the harmattan, in the south no traces of this were found. In the rainy season, which is the best for observing as the atmosphere is always very clear, especially after the storms, small streams quickly become torrents, and progress is often greatly delayed on this account. During the second tour of the Commission the rains, which were exceptional, continued till the middle of November, when they were at once followed by spells of harmattan, which often lasted for seven days. From the middle of January till the end of the work, rain and tornadoes were of almost daily occurrence. In Southern Nigeria, on the south side of the high plateau which forms the watershed between the Katsena and Cross rivers, the clouds had so banked up as to obscure the top from the foothills below, and on this account one of our Commission was detained for thirty-five days at one of the beacons on the plateau before the clouds lifted sufficiently to allow him to observe the forward angle.

The health of the Commission during both tours was excellent, although in the valleys the climate is trying, being damp. In one's tent the temperature in the middle of the day at times rose to 110°, but at night, fortunately, it as a rule fell, while on the high ground it seemed comparatively cold.

In the forests of Southern Nigeria the climate is very different from that in the bush country. It is very enervating, and one even longed for the bush country, as here the sun but rarely penetrates, owing to the height of the trees and the thickness of the foliage. It was impossible ever to keep properly dry, for when there was no rain there was a continual drip from the trees, it being the rainy season when the Commission were in this part of the country.

The British and German Commissions met at Bashu, and after comparing maps and results agreed on a provisional boundary, signing the protocol on April 16, 1909. On the following day they separated, the Germans proceeding home *viâ* Duala, while we proceeded to Ibi *viâ* the Sonkwala valley, which was now quite friendly, the natives coming to see us and bringing food. At Ibi we got back to civilization once again, and, thanks to the Resident, Captain Rowe, we were able to have a proper roof over our heads again.

The river Benue was now at its lowest, so the journey downstream to Lokoja had to be made in steel barges. After a couple of days' stay here, we proceeded by a stern-wheeler to Forcados and caught the steamer for England, where we arrived on June 8, 1909.

APPENDIX.

Before leaving Yola the German Commissioner suggested that we should adopt the values for the top of a hill called Gijaro and of another called Uom, distant about 15 miles, which had been determined by the Yola-Chad Boundary Commission in 1903, and utilize them as the ends of a base for our new survey. This was readily agreed to, the mean of the British and German values being adopted. The tedious processes of measuring a base and observing for latitude and longitude in the tropics were thus obviated and much time saved.

The framework of the map of the country traversed was formed by triangulation, there being 108 triangles in the total length of approximately 320 miles. These triangles kept as close to the agreed azimuth line as was possible, but on reaching Abakun (lat. 7° 44′ 8″·7 N., long. 10° 54′ 1″·436 E.) the triangulation was carried north-west for a distance of about 15 miles, and then south-west through the Kungana pass to Kwossa, joining the line once more near Oodi, lat. 7° 24′ 0″·2 N., long. 10° 30′ 58″·339 E. This diversion was necessitated by a block of mountains crossing the boundary-line which could not be crossed with carriers.

Tripod beacons about 20 feet high were used to mark the trigonometrical points. Their tops were thatched with grass, while white calico was wound round the tips so as to show them up against a dark background. Even with these precautions it was the exception rather than the rule for the beacons to be seen, so the majority of the observations were taken to helios placed over the trigonometrical points.

At three points along the boundary-line, viz. Gankita (N) near Beli (V_1), and near Chittan Gida (E_2), the latitude and azimuth were observed and the necessary corrections made, while near Chittan Gida, about 220 miles south-west of Yola, a small check base of 2990·734 feet was also measured. From this new base the side D_3E_3 was calculated, giving—

Length	8626·24 feet.
Length by triangulation	8628·78 „
Difference	2·54 „

It was also intended to observe a latitude at boundary post No. 5, where our survey joined up with that of Captain Woodroffe, but, the rains having set in, it was impossible to get any observations to either sun or stars.

On plotting our value of boundary post No. 5, it was found to be approximately 3600 feet east of the line joining the centre of Yola with the centre of the Cross river rapids, whose agreed mean azimuth was 46° 44′ 27″ E. of north. Assuming the longitude of Calabar (which was fixed by chronometer journeys, and from which the longitude of the centre of the Cross rapids was determined) as correct, the longitude of Yola becomes 12° 28′ 53″ E. (approximate), *i.e.* 36″ west of the position agreed upon by the British and German Governments, but very near the *arithmetical* mean between the observed British and German longitudes of the centre of Yola obtained in 1903 by the Yola-Chad Boundary Commission.

The heights of all the trigonometrical points were observed and calculated, while the barometer and hypsometer were used to determine the heights of those hills which were not included in the triangulation.

The detail of the country was filled in by plane-tabling, the presence of very large quantities of iron in the hills and their neighbourhood rendering the compass very unreliable, except for road-sketches between fixed points. The mean variation of the compass along the boundary-line is 11°·8 W. (variation between 9°·5 and 15°).

The map of the country was drawn on a scale of 1 : 125,000.

At Bashu, the end of the line to be surveyed, where there was a boundary pillar fixed by Captain Woodroffe, the British calculations differed from those of the Germans by 0″·37 lat. and 2″·22 long.

The Commission was divided into five parties for carrying out the survey. Three of them were provided with 5-inch micrometer theodolites, and they observed the angles for triangulation and plane-tabled in the neighbourhood of the trigonometrical stations, while the remaining two carried out the plane-table work, made preliminary reconnaissances, and erected beacons. All the sections were provided with helios, so that it could always be arranged, if necessary, to observe to four points on the same day from a trigonometrical point in addition to other points which were visible. This arrangement worked very well.

The time taken on the work was 373 working days, inclusive of Sundays; on 62 of these work had to be suspended owing to bad weather, while 15 more days were lost on account of the trouble with the natives in the Sonkwala valley. This gives a total of 296 actual working days, including Sundays, during which 4000 square miles of country were surveyed.

MR. FERGUSSON'S MAP OF THE LOLO COUNTRY.*

Mr. W. N. Fergusson, whose map of the portion of Se-chuan lying west of the Min and north of the Tung rivers was published in the *Journal* for December, 1908, has since done a similar piece of work for a more southern part of the same province, principally south of the

* Map, p. 512.

Tung river, and including the little-known area inhabited by the Independent Lolos. Like the former map, the present contribution is based, so far as Mr. Fergusson's own work is concerned, on a plane-table sketch, but this has been supplemented by information collected by inquiry from the natives. We hope to print shortly some notes by Mr. Fergusson himself on the country in question, and the mode of constructing the map, but as the traveller has been unable to supply these before once more leaving this country, we publish the map without waiting for the commentary. Something has been done of late years towards filling in the blank space which represented the Independent Lolo country in Mr. Colborne Baber's map of 1882 (R.G.S. Supplementary Papers, vol 1, Part I.) by the work of Bonin, D'Ollone, and others, but the greater part of the area has remained so little known that Mr. Fergusson's sketch will be useful, even though it can make no claim to accuracy in the parts not actually visited. Unfortunately, Mr. Fergusson has not clearly distinguished the routes followed by himself from those inserted from native information, though it is evident from his original survey sheets that he followed the route traversing the western part of the area, between Ya-chou in the north and Ning-yuan-fu in the south. This, however, had already been followed by other travellers. The map shows a number of routes across the Lolo country, north of Bonin's and D'Ollone's tracks (which hardly extended north of 28°, so far as the country of the independent Lolos is concerned), and inserts a large amount of detail not shown on previous maps. It also marks the spot at which the late Mr. J. W. Brooke met his tragic death.

FURTHER EXPERIMENTS ON DEW-PONDS.*

By EDWARD A. MARTIN, F.G.S.

In April last I had the honour of reading a paper before the Research Committee on the subject of Dew-ponds.† The present paper is to be regarded as a continuation of that paper, and although the summer and autumn of 1909 were not conducive to a successful study of the subject, I think that perhaps sufficient new material has accrued to justify a further contribution on the subject, and to draw deductions therefrom. In resuming my observations on the Sussex Downs early last summer, my first duty was to repair my experimental pond. During the late autumn of 1908 it had filled rapidly, and with the heavy falls of snow which occurred during the winter, which was artificially piled around the edge in accordance with Clutterbuck's suggestion, the result was satisfactory, in that the pond became practically full, although not with dew. With the break up of the frost, the pond showed signs of serious leakage. This may possibly have had its origin in the disintegrating power of frost, the damage as usual appearing when the thaw set in, or it may have been owing to the fact that a deep hole showed itself in the clay bottom where a thick stick had almost if not quite pierced it. Visiting the

* Research Department, April 21, 1910.

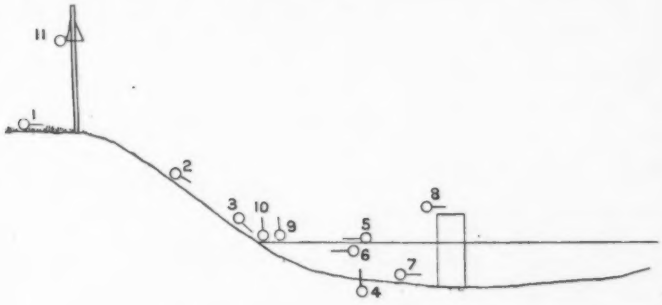
† See the *Geographical Journal* for August, 1909.

pond in December when the temperature of the air was several degrees below freezing-point, nearly the whole of the water was a mass of ice, and it was quite easy to realize that the sharp edges of the thickening ice may have found a weak spot in the bottom and caused a leakage. Taking a lesson from the "pinching" of an arctic vessel when caught in the ice, it should be noted that it is well to construct the sides of a pond with very gradually sloping banks, so that the ice, instead of piercing the banks, will be lifted as expansion takes place. I took opportunities during the winter to visit the various ponds referred to in my former paper under arctic conditions, and found that their margins were well adapted to this end. I may remark that a journey over the Downs in mid-winter at night-time, with only the stars to guide one, with the thermometer considerably below freezing-point, and an icy blast blowing from the north-east was an experience to remember. The Downs in such circumstances would no doubt serve as an excellent training-ground for antarctic explorers.

There was a great shortness of rainfall in February, 1909 (0·20), at Clayton Mills (584 feet), and the pond completely dried up, with much desiccation of the bed. Subsequent rains showed the centre as holding water; and on June 5, when I again commenced to reside there, the water-surface was about 4 feet across and about 6 inches deep. The bottom and edges I then smoothed down until they were as smooth as glass, and there seemed a prospect of the pond filling, but in a few days I found, on returning home one evening, that a flock of sheep, having trampled down the fence, had drunk the greater part of the water, and had made many holes in the clay with their pointed cloven fore hoofs. Again we trampled and smoothed the clay out, and then to encourage the dew, or arrest the rain should that come first, we laid an artificial roof of faggots over the pond, on the principle of the Neolithic hut-dwelling. I must confess that it did not have much effect in either direction, but perhaps the experiment was not continued long enough. I should mention that on one occasion on which I placed in position some faggots, supported over the pond, I covered them with a waterproof sheet 6 feet square. On the following morning (June 12) I found considerably more dew on the under side of the sheet than on the outside. Here there was rising dew moistening the sheet, and this had probably its origin from evaporation of the pond itself. On the following morning, however, there was dew only on the upper side of the sheet. There was no rain from June 10 to June 21 inclusive, at the end of which time the pond was dry, and large cracks had appeared at the sides. A storm on June 24 and following night gave 4 inches of water in the pond, and with the swelling of the clay the cracks disappeared. I have referred more particularly to rainfall as affecting the pond, as this was the more noticeable in its effects. Hitherto there had been but little dew, and the only fog on the Downs (June 17) had been instrumental in preserving the clay in a damp condition. On July 1 I determined to excavate the pond to a greater depth, and to make some alterations in the bed of the pond. We first removed the chalk puddle, keeping that for future use, and next the clay puddle and basement of planks and straw. The clay was moist all the way through, although when thrown up on the bank it became in a day or two as hard as brick. The moistness of the clay seemed to show that there may have been some slight percolation through the bottom. Next the planks on which the clay rested were removed. These had retained their colour well, and were not decayed. They were moist on the upper side on which the clay rested, and beneath to a slighter extent where they rested on the straw. The straw and the wood-wool, though much crushed, were but slightly moist, but well preserved. In laying down the new foundations, the planks were laid down immediately on the chalk. On these were laid straw to a much greater thickness than formerly,

and on the straw was laid a fresh supply of well-puddled clay. The clay resting on the straw, a greater thickness of clay was necessary, as, of course, the straw yielded to each mass of puddled clay as it was put down, and the clay was made to overlap like tiles on a house. It was no easy task to make such a bottom water-tight, but it was necessary that it should be done in order to test the truth or otherwise of modern theory. The dew-pond was finished on July 13. This was followed by a few dry and hot days, when artificial watering had to be resorted to to prevent cracking of the clay. However, by July 20 there had accumulated sufficient water to enable useful observations to be taken.

The dewy night of July 19 (the first for a long time) made no measurable alteration in the depth of the pond; and this was so on many subsequent occasions. Repeatedly, when there had been heavy dews on the grass, I looked to see if there had been any rise in the pond, but without finding it. Not only so, but the dry puddled bank showed no signs of dampness.



Diagrammatic section of Pond showing position of thermometers during nightly observations.

The thermometric observations shown in the tables on pp. 442, 443 were made while yet there was water in the pond.*

In the 24 hours ended July 28 (7 a.m.) 1·21 inches of rain fell. A rain-gauge in the water of the pond received 1·41 inches. A rain-gauge at Ditchling (below the hills) measured 0·88 inch only. In the case of heavy rains, my gauge on the hill generally exceeded that in the valley. In the case of light rains, more water is usually measured in the valley than on the hill. The result of the rain was to considerably increase the water-surface of the pond, the depth in the centre being 4½ inches. The nights since my arrival on the downs on June 6 had been very free from dew. On the night of August 4 there was a heavy deposit of dew, the fourth night of this kind since the date mentioned. Dew immediately appeared on the thermometers which were put out at 10 p.m. There was no rain from July 31 to August 15 inclusive, and the water almost disappeared. On the morning of August 11 there was a thick fog everywhere, but it had not moistened the clay puddle above the pond, and this remained quite hard. This was the first good downland fog for two months. What it did do was to prevent evaporation. On the morning of August 12 there was an inch of water left in the pond. The grass was wringing wet with dew at 7 a.m., but there was none on the hard dry puddle.

* The Fahrenheit scale has been used throughout.

Date and time.	July 19, 1909.				July 20.	July 20.						July 21.	July 21.				July 22.
	8.45 p.m.	10 p.m.	11 p.m.	Min.	7 a.m. (sun shining).	7.45 p.m.	8.15 p.m.	8.45 p.m. (wind rising).	9.15 p.m.	9.45 p.m.	Min.	6.45 a.m. (very cloudy).	8.15 p.m.	8.45 p.m.	9.30 p.m.	Min.	7 a.m. (cloudy).
1. On grass	55½	54	50½	43½	58	56	57½	54½	53	52	48½	55	57	56	56	53	57½
2. On dry puddle ...	55	55½	52	46	53	58½	57½	54	57	56	51½	56½	58	58	57½	52	58
3. On wet puddle ...	56	55½	52	45½	53½	63	60	58	58	56	—	—	58	57½	57	52½	57½
4. In puddle under water	60	58	58	—	52	61	60	61	60	58	55	56	60½	60	59½	52	57
5. Surface air, *i.e.* immediately above water-surface	56	55	52	52	52	57	57	56	55	55	—	—	58	58	57	—	57
6. Surface water ...	58	56	56	53	53	59	58	58	57	56½	—	—	58	58	58	—	57
7. Bottom water ...	—	—	—	—	—	60½	59	59	58½	59	51	56	59	59	58	53	57½
8. Top of rain-gauge in middle of pond	58	56	52½	46	54	57	57	57½	56	59½	51	56½	57	57½	57	52	58
9. Wet bulb over water-surface	54½	54½	52	—	—	56	55½	56	55	55	—	—	Foggy with high wind; grey cloudy sky; little variation throughout, owing to completely clouded sky.				
10. Dry bulb do.	58½	56	53½	—	—	58	58½	58½	57½	56½	—	—					
Dew-point do.	50·9	53	50·5	—	—	54·2	52·8	53·7	52·7	53·6	—	—					
						Air not still enough for much dew-fall.											

Date and time.	July 28.								July 29.	July 29.			July 30.
	7.45 p.m.	8 p.m.	8.15 p.m.	8.45 p.m.	9 p.m.	9.30 p.m.	10 p.m.	Min.	7 a.m.	8 p.m.	9 p.m.	Min.	7 a.m.
Grass on top of bank ...	55½	54	53½	52	51½	51½	51½	50	58	57½	56	56	60½
Dry puddle on bank ...	56½	55½	55½	54½	54	53	52	50½	58	58	56	55½	61
Wet puddle at edge of water	57	56	55½	55	55	54	53½	51	57	58	56½	55½	60
Puddle under water... ...	62	61	61	60	58	58	56	—	56	56	58*	—	59
Surface air, *i.e.* immediately over water	55	54	54	54	54	54	53	—	58	56	56	—	61
Surface water	58	57	56	56	57	56	56	—	57	58	59*	—	60
Bottom water	62	61	61	60	60	60	58½	55	56	60	58½	55	59
On top of rain-gauge in centre of pond	56½	56	56	55½	56	55	53½	52½	59	57	56½	—	61
Wet bulb: in surface air ...	55	54½	54	53	52½	51½	51½	—	—	59	56	—	—
Dry bulb: ditto ...	56½	55	57	56½	56	55	53	—	—	59	56	—	—
Dew-point	53·6	54	51·2	49·8	49·2	48·2	50	—	—	59	56	—	—
Air 3 feet above bank ...	58 light south-east wind.	58	58	57 slight dew on grass.	57	56 too windy for dew	54	—	58 no dew, dull and oppressive, no sun, windy.	58	56 * Warmer since 8 p.m.	—	60

Date and time.	July 30.					July 31.	July 31.				Aug. 1.	
	7.30 p.m.	8 p.m.	8.45 p.m.	9.45 p.m.	Min.	7 a.m.	9 p.m.	10 p.m.	11 p.m.	Min.	9 a.m.	
Grass on top of bank ...	58½	58	56½	55	55	61½	56½	55	55	55	68½	
Dry puddle on bank ...	59	58½	57	56½	—	—	57	56	56½	—	—	
Wet puddle at edge of water	59	59	57	57	55	59½	58	56½	56½	55	66	
Puddle under water... ...	63	62	60	60	—	59	61	59	60	—	65	
Surface air, *i.e.* immediately over water	59	59	58	57	54	62 (in sun)	58	57	56	54	66½	
Surface water	61	60	59	58	56	60	60	58	58	58	67	
Bottom water	62½	62	61½	62	59	60	60½	61	60	57	63	
On top of rain-gauge in centre of pond	59	58½	57	57	—	64 (in sun)	—	55	54	—	—	
Wet bulb: in surface air ...	59	59	57	56	—	—	58½	57	57	—	—	
Dry bulb: ditto ...	59½	60	57	57	—	—	59	57½	57½	—	—	
Dew-point	58·5	58·1	57	55·1	—	—	58	56·5	56·5	—	—	
Air 3 feet above bank ...	60	60	58	58	—	63 (in sun)	59 clear full moon: dew	58	58 clouded over	—	63 cloudy, windy, sunny.	A clear evening at 9 p.m., but becoming clouded over, reduction in temperature was arrested all round, radiation being much reduced.

The wet puddle around the edge seemed to be more wet than usual, which may have been due to capillarity. The pond and mill had no fog around them, but seen from Hassocks station below the hill, 2 miles away, the mills were invisible, being hidden by a valley fog.

The dry, sunny, and dewy weather broke up on August 16, up to which date the observations on pp. 445, 446 were made.

It seemed advisable, in order to ascertain the variations of temperature and to test the theory of dew-deposition in a pond, to take hourly temperatures for 24 hours in a selected dew-pond, and at various positions around it. I selected Upper Standean pond (No. 17) for the purpose. This pond is a chalk-puddle one, and contained very clean water. It is situated at a height of 560 feet, and was 160 feet around the water's edge, with a margin, partly grass-grown, measuring 16 feet from the water's edge to the top of the bank. The experiment commenced at 7.30 a.m. on August 14, a hot sunny day. During the night following, a clear star-lit night, there was a heavy dew, and the circumstances were all that could be desired for the purpose. Fourteen thermometers were placed out in the positions shown in the sketch. The table on p. 447 shows the results.

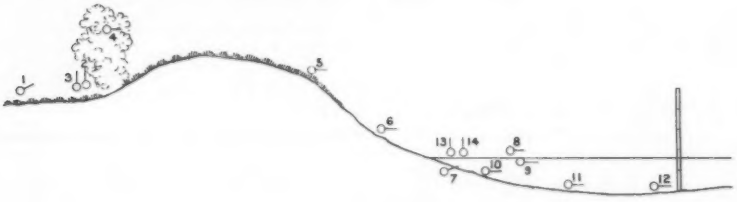


Diagram showing position of thermometers during 24 hours' observation at Upper Standean Pond.

An examination of this table shows that, during the hours of possible dewfall the temperature of the surface air was, with but one exception (12.30 a.m.), always lower than that of the surface water, and that on no occasion did that of the water approach dew-point. During the same hours the dry puddle was always colder than the wet puddle. The dew-point over the water was always higher than that over the grass; and the surface air was never below dew-point. A stick marked with inches and half-inches was sunk in the middle of the pond, and the depth shown was 1 foot 8¼ inches. On September 5 this had increased to 1 foot 9½ inches. The pond is drawn on largely for sheep and cattle. In one morning three flocks of sheep, numbering three hundred each, and cows to the number of twenty visited the pond. With the break-up of the fine weather on August 16 dewy nights ceased. The whole of the rainfall for August, 2·95 inches, occurred from that date.

So far as the experimental pond was concerned, the rainfall of August 17 (0·43 inch) saved it from complete desiccation, and with 0·78 inch on August 19 and 20 experiments with it were again possible. By August 24 there was a depth of 8 inches in the pond, and with 0·76 inch on August 24 the pond was now 10 inches deep. Watching it in a heavy rain, it was observable how that the impermeable clay caused the water to race down runnels which it made into the pond. Resuming observations in and around this pond, the results are shown in the tables on pp. 448, 449.

Date and time.	Aug. 4.			Aug. 5.			Aug. 5.				Aug. 6.		
	10 p.m.	11 p.m.	Min.	4.45 a.m.	6.45 a.m.		8 p.m.	9 p.m.	10 p.m.	Min.	6 a.m.	7 a.m.	
Grass on top of bank ...	49	49	43½	45	53	10 p.m., moon shining, windy, but heavy dew; ruddy sunrise at 4.30 a.m., when temperatures were just beginning to rise; wet and dry bulbs showed saturation of the air throughout the night. Surface air below dew-point all night.	53½	48	50	47½	52½	56	Starry and quite clear at 9 p.m., but *no* dew on grass. Slightly overcast and warm at 10 p.m., with a slight dew.
Dry puddle on bank ...	53½	52½	47½	48½	53½		58½	55	54½	51½	54½	58	
Wet puddle at edge of water	55	54	49	50	53½		60	57	55½	52	54½	57½	
Puddle under water	62	60	—	56	56		65	61	60	—	56	—	
Surface-air, *i.e.* immediately over water	53	52½	48	50	55		56	56	56	52	54	59	
Surface water	57	56½	53	52	54		61	59	58	53	54	56	
Bottom water	58	57	52	52½	54		63½	61½	60	54½	54½	56½	
On top of rain-gauge in centre of pond	54	53½	47½	48½	60½ (in sun)		56	53½	57½	52½	59	66 (sun)	
Wet bulb: in surface air ...	54½	54	—	50½	51		55½	54½	53	—	—	56½	
Dry bulb: ditto ...	54½	54	—	50½	51		58	56½	58	—	—	60½	
Dew-point	—	—	—	—	—		53·3	52·6	48·5	—	—	53	
Air 3 feet above bank ...	54	—	—	51	60 (in sun)		61	60	60	—	58	62	

Date and time.	Aug. 6.				Aug. 7.	Aug. 7.				Aug. 8.	
	8 p.m.	9 p.m.	10 p.m.	Min.	7 a.m.	8 p.m.	9 p.m.	10 p.m.	Min.	8 a.m.	
Grass on top of bank ...	53	52	51½	48½	57½	59½	58½	57	54½	71	At 8 p.m. there was a slight dew on grass; at 9 p.m. heavier dew with much haze overhead; at 10 p.m. grass very wet.
Dry puddle on bank ...	58	56	55	53	56½	63	62½	60	54½	63	
Wet puddle at edge of water	58	57½	54½	53½	57½	63	62½	61	55½	65 (sun)	
Puddle under water ...	67	58	53	—	60	68	68	68	—	66	
Surface air, *i.e.* immediately over water	58	56	54	52	59 (sun)	59	61	60	54½	72 (sun)	
Surface water	60	58	57	55½	56½	63	64	64	58	62	
Bottom water	61	61	58	54½	56	67	66	65	58½	63	
On top of rain-gauge in centre of pond	57	57	56½	52½	63	65	63	61	55	72½ (sun)	
Wet bulb: in surface air ...	57½	56	54	—	59	61½	60	59½	—	65½	
Dry bulb: ditto ...	58½	58½	56½	—	60½	65	63	61	—	68½	
Dew-point	56·6	53·7	51·6	—	57·7	58·6	57·4	58·2	—	63·2	
Air 3 feet above bank ...	60	58	58	—	62 (sun)	66	64	61	—	68	

Date and time.	Aug. 8.			Aug. 9.		Aug 9.			Aug. 10.		Aug. 11.			Aug. 12.
	9 p.m.	10 p.m.	Min.	7 a.m.		9 p.m.	10 p.m.	Min.	7 a.m.		9 p.m.	10 p.m.	Min.	7 a.m.
Grass on top of bank ...	56	57	52	60½	At 9 p.m. there was a north-east wind and no dew; at 10 p.m. much lightning. Note similarity of temperatures at 7 a.m.	59	56	50	57½	Clear starry night, but windy.	57½	59	49½	61½
Dry puddle on bank ...	60½	60	55	61½		62	60	52½	57½		60	61	52½	58½
Wet puddle at edge of water	60	59	55	61		62	60	53	56½		61	61½	54½	59½
Puddle under water	64	62	—	61½		66	63	—	59		63	63	—	60
Surface air, *i.e.* immediately over water	59	59½	54	60½		61½	59	57	59½ (sun)		65	61	—	62
Surface water	62	61	58	61		65	63	52	58		62	61	—	60
Bottom water	65	63	57	60		64	63	55	56		—	—	—	—
On top of rain-gauge in centre of pond	61	68½	55	61½		63	61	52	61½ (sun)		59½	62	51½	65 (sun)
Wet bulb: in surface air ...	56½	56	—	—		58½	58	—	—		58½	61	—	62½
Dry bulb: ditto ...	60½	60	—	—		62½	61	—	—		60½	63	—	64½
Dew-point	53	52·5	—	—		55·1	55·4	—	—		56·7	59·3	—	61·4
Air 3 feet above bank ...	61	62	—	60		64	62 (slight dew)	— (heavy dew)	62		61 (dewy)	64	— (heavy dew)	69 (sun; heavy dew)

Date and time.	Saturday, August 14, 1909.																Sunday, August 15, 1909.							
	7.30 a.m.	8.30 a.m.	9.30 a.m.	10.30 a.m.	11.30 a.m.	12.30 p.m.	1.30 p.m.	2.30 p.m.	3.30 p.m.	4.30 p.m.	5.30 p.m.	6.30 p.m.	7.30 p.m.	8.30 p.m.	9.30 p.m.	10.30 p.m.	11.30 p.m.	12.30 a.m.	1.30 a.m.	2.30 a.m.	3.30 a.m.	4.30 a.m.	5.30 a.m.	6.30 a.m.	7.30 a.m.
1. Grass, over bank, in shade	67	71	82·5	82	80·5	87	83·5	81·5	76	72	68	63·5	58·5	56	55	60	62	62	62	61	58·5	55	55	68·5	73
2. Wet bulb on grass in shade	60·5	67	69	73	72	70	72·5	73·5	71·5	69·5	66	64	60·5	58·5	58·5	60	62	62	61·5	61	60	57	58	66·5	69·5
3. Dry bulb on grass in shade	67	70	76	79	77	78	78	77	75·5	72·5	67	64·5	61	59	58·5	60	62	62	62	61·5	60	57·5	58	66·5	69·5
4. Dew-point ditto	—	—	—	—	—	—	—	—	—	—	—	63·6	60·1	58·1	58·5	60	62	62	61	60·5	60	56·6	58	66·5	69·5
In bush, 3 feet up, on bank	66	70	79·5 (sun)	79 (sun)	75	76	82	82	80	74	71	65	67	66	65	65	65	66	66	67	66	64	64	67	69
5. Grass, top of bank, in shade	64	68	80 (sun)	81 (sun)	77	79	86·5	90	80	74	70	64·5	61	56	58	58·5	60	59·5	59	58·5	56	55	54	61	65·5
6. On dry puddle ...	67	66	71·5	74	72	75	75	79	76	73	69·5	65	62·5	61	60	62	62	61	60	60·5	58	58	58	63	65·5
7. In wet puddle ...	63	63·5	66	69	68	70	70	71	72	71	70·5	69·5	68·5	67	66	65	64·5	64·5	64	63	63	62·5	62	63·5	64·5
8. Surface air ...	68	71	69	73	74	77	75	76	76	76	74	68	69	68	68	68	66	67	67	65	64	64	68	69	72
9. Surface water ...	68	68	69	70	71	74	74	76	76	76	76	72	72	71	70	69	68	66	67	67	66	66	66	68	70
10. Six inches water	67·5	68·5	69·5	71·5	72	74	70	76	77	77	76	75	73·5	72	72·5	72	71	71	70	69·5	68	68·5	68	68	68·5
11. One foot water ...	67	68	70	72	72·5	75	76	77	77	76·5	76·5	74·5	74	73·5	73	72	71	70	70	68·5	69	68	68	68·5	69
12. Bottom water 2 feet	—	—	71	74	74	74	75	77	76	76	78	75	75	74	73	73	72	71	71	70	69	68·5	68·5	69·5	69
13. Wet bulb in surface air	63	64	63·5	66·5	67	67·5	67·5	73·5	74·5	69	68·5	65	62·5	61·5	62	63·5	63·5	63·5	62·5	63	61	61	62	68·5	70
14. Dry bulb in surface air	66	68·5	70·5	72·5	72	73·5	74·5	74·5	76	75	73·5	66·5	62·5	62	62	63·5	64	63·5	62·5	64·5	61·5	61	62·5	72	74
Dew-point ditto, *i.e.* immediately over water	—	—	—	—	—	—	—	—	—	—	—	64·6	62·5	61·1	62	63·5	63·1	63·5	62·5	61·8	60·6	61	61·6	—	—
Remarks ...	Fog cleared away; sunny.											Mist in valleys and on distant downs; heavy dew on grass.												Sunny; much mist everywhere; heavy dew on grass.	

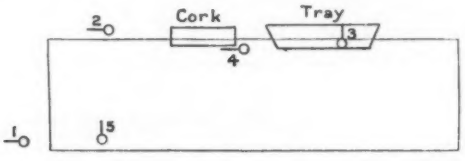
Date and time.	Aug. 21.		Aug. 22.		Aug. 22.		Aug. 23.		Aug. 25.		Aug. 26.	Aug. 26.		Aug. 27.	
	11 p.m.	Min.	8 a.m.		10 p.m.	Min.	7 a.m.		10 p.m.	Min.	7 a.m.	10 p.m.	Min.	7 a.m.	
Grass on top of bank ...	46	42	58½ (sun)	Surface air under dew-point at 11 p.m.	52	45½	55	Misty and overcast at 7 a.m., note similarity of temperatures.	53	49½	52½	53½	45½	49	Grass dew-drenched at 7 a.m., giving a grey appearance to the downs.
Dry puddle on bank ...	47	45	51½ (sun)		52½	47½	55		54	50	52½	54	47	49½	
Wet puddle at edge of water	48½	47	56		52	47½	55		54½	50	53	55	48	49	
Puddle under water ...	53	—	55		54	—	54		61	—	56	58	—	53	
Surface air, *i.e.* immediately over water	46½	43	60 (sun)		52½	47½	55		54½	50	52½	55	47	49½	
Surface water	53	49	55		54	52	54		56½	53	54	58½	52	52½	
Bottom water	59	52	53½		54	52½	55		61	55½	55½	58½	52½	52½	
On top of rain-gauge in centre of pond	47½	45	63 (sun)		53	47½	56		53½	49	52	55	47	50	
Wet bulb: in surface air ...	48½	—	55		51½	—	54½		54½	—	53	54½	—	51	
Dry bulb: ditto ...	49½	—	60		53½	—	55½		59½	—	53	55½	—	51	
Dew-point	47·4	—	50·6		49·5	—	53·5		50	—	53	53·5	—	51	
Air 3 feet above bank ...	49	—	56 (sun)		54 (showery)	—	56		55 (starry)	—	53 (damp and cloudy)	55	—	52 (sun)	

Date and time.	Aug. 27.				Aug. 28.		Aug. 29.			Aug. 30.	Aug. 31.			Sept. 1.	
	8 p.m.	9 p.m.	10 p.m.	Min.	7 a.m.		8.30 p.m.	9.30 p.m.	Min.	7 a.m.	9 p.m.	10 p.m.	Min.	7 a.m.	
Grass on top of bank ...	54	54	50½	43	50½	Surface air below dew-point at 8, 9, and 10 p.m. on Aug. 27.	52½	52½	51	53	40½	39	37½	42	The night was clear, and the low temperatures are very noticeable. There was heavy dew by 9 p.m. The rapid fall of the atmospheric temperatures is strikingly shown in comparison with the water temperatures.
Dry puddle on bank ...	56	56	52½	45½	51		53	52½	51	53	44	41½	40	42	
Wet puddle at edge of water	56½	55	52	45	50		53½	53½	52	54	45½	43½	41	43	
Puddle under water ...	61	60	59	—	54		60	58	—	56	53	52	—	48	
Surface air, *i.e.* immediately over water	56	55½	52½	46	51½		53½	54	—	54	45	43½	41	43	
Surface water	60	58	57	51	52		58	56	—	55	52	50½	45	45	
Bottom water	59	59½	59½	53	53		59	58	54	55	55½	54½	46	46	
On top of rain-gauge in centre of pond	56½	56½	52½	45	52		54	54½	52	54	48½	44	—	42½	
Wet bulb: in surface air ...	57	57	53½	—	51½		—	—	—	54	—	44	—	42½	
Dry bulb: ditto ...	57½	57½	53½	—	52		—	—	—	54	—	44	—	43½	
Dew-point	56·5	56·5	53½	—	51		—	—	—	54	—	44	—	41·3	
Air 3 feet above bank ...	—	—	—	—	—		55	55	—	53 (cloudy)	49	49	—	41	

Date and time.	Sept. 1.			Sept. 2.		Sept. 5.			Sept. 6.			Sept. 7.		Sept. 8.		
	8.30 p.m.	9.30 p.m.	Min.	7 a.m.		8.30 p.m.	9.30 p.m.	10.30 p.m.	Min.	7.30 a.m.	10.30 a.m.	10 p.m.	Min.	8 a.m.	11 a.m.	
Grass on top of bank ...	44	42	35	41½	Notice the fall of air temperature whilst the water and the puddle under the water remained comparatively high. Surface air below dew-point at 8.30 and 9.30 p.m.	51	49	49½	49½	49½	61	47	37½	51	—	Slight dew on grass at 8.30 p.m., but wind got up by 10.30 p.m. and a storm raged during night, with however not much rain.
Dry puddle on bank ...	44	43	36	40		51½	49	49½	49	57½	59½	49	37	51	—	
Wet puddle at edge of water	46	44½	38½	42		52½	50	50½	50	58	60½	49	40	47½	67½ (sun)	
Puddle under water ...	52	50	—	46		56	56	56	—	57	60	52	—	48	52½	
Surface air, *i.e.* immediately over water	45½	43½	37	43½		52	49½	51	50	59½	62	48	39½	56½	65½ (sun)	
Surface water	50½	49	36½	44		54½	53½	53	51½	57½	60½	51½	44	49	69½ (sun)	
Bottom water	53	51½	45	45		57½	57	56½	54	57½	59½	53½	46	47½	53½	
On top of rain-gauge in centre of pond	45	44	—	40½		52	50	51½	—	59	62	48	—	57	—	
Wet bulb: in surface air ...	46½	45	—	43½		51	50½	50½	—	59	—	49	—	49	57½	
Dry bulb: ditto ...	46½	45	—	44		52½	51	51½	—	59	—	49	—	51½	63½	
Dew-point	46·5	45	—	42·9		49·5	50	49·5	—	59	—	49	—	46·4	—	
Air 8 feet above bank ...	47	46	—	44		55	52	54	—	60	62	50	—	49	—	
																North wind in the morning: cold where exposed to it.

It must not be supposed that all the water which falls on the bank of a chalk-puddle pond runs down into the pond. Although many ponds have enormous margins, these are proved by testing to soak up almost all of the moderate rains, except that which falls a foot or two above the actual edge of the pond. But this must be modified in the case of one or two ponds, notably that at Ditchling Beacon (No. 5), and concreted ponds when the cracks are kept in a state of repair, such as that on Stanmer Down (No. 30). In heavy rains, however, the area available for drainage is undoubtedly much larger, and in such times when there are artificial runnels emptying through the bank itself, these undoubtedly feed the ponds enormously. Heavy rains quickly saturate the puddle. There is a winding lane leading off the down at Clayton to the farm-pond below. The lower portion is over chalk-marl, the impure chalk at the base of the Lower Chalk. In ordinary rains the water quickly soaks through. The rain of August 23 and 24 was persistent, and the percolating power of the chalk marl had almost ceased. Miniature rivers then ran down the lane, and finally made their exit in the pond. The pond is clay puddled, but in consequence of the unusual entrance of numerous small chalky streams into one corner of it, the green water showed their tracks through it in the shape of sinuous white courses, preliminary to the sinking of the finely divided chalk to the bottom. This ceased with a marked diminution of the rainfall.

If dew is deposited on a pond, it might be possible to ascertain the amount of accession of such water by floating suitable receptacles on the pond. In order to satisfy myself that such would be a true test, it was necessary first of all to ascertain if the temperature in a confined receptacle would differ from that of the surrounding water. I therefore placed thermometers in water in the positions shown in the diagram. The results are tabulated below. They satisfactorily showed that the temperatures were with slight exception identical.



Section of water receptacle showing comparison of water inside and outside of floating tray.

Date and Time.	April 13, 1909.				
	8.45 p.m.	9.15 p.m.	9.45 p.m.	10.15 p.m.	10.45 p.m.
I. Air 1 inch above soil	51	49	49	49½	49½
II. Air over surface of water	52	50	50	49½	49½
III. Water in tray on water	55	52½	51	50	50
V. At bottom of water	55	52½	51	50	49½

The unusually rapid fall of the temperature of the water was due to escape of heat from sides of the receptacle; the result would have been different had receptacle been sunk in the earth It will be observed that Nos. III. and V. were practically identical.

Date and Time.	April 14, 1909.					April 15.	
	8.15 p.m.	9.15 p.m.	10.15 p.m.	10.45 p.m.	Min.	8.30 a.m.	9 a.m.
II. Air over surface of water	51	47½	46	44½	37	48	50½
III. Water in tray on water	49	48	47	47	39	42½	43½
IV. In 1-inch water near but not under tray	49½	48½	47½	47	—	42½	43½
V. At bottom of water	49½	48½	47	47	—	42½	43½

No. III. was ½° only less than main body of water during 8.15 p.m. to 10.15 p.m. Nos. IV. and V. were identical except at 10.15 p.m.

Date and time.	April 16, 1909.				April 17.
	8 p.m.	9 p.m.	10 p.m.	11 p.m.	8 a.m.
II. Air over surface of water	47½	46½	45	41½	50
III. Water in tray on water	49½	48½	47½	46½	46
IV. In 1-inch water as on April 14 ...	50½	49½	48½	47½	46½
V. At bottom of water	50½	50	48½	48	45

Nos. IV. and V. practically identical up to 11 p.m. No. III. lost heat rather more rapidly than IV.

On the evening of August 26 I placed a small shallow glass receptacle so that it floated on the water of the experimental pond, and in this I placed a measured quantity of water. The night was a very dewy one, but in the morning exactly the same quantity of water remained. The grass around the pond was drenched with dew. In the raingauge 0·003 inch was measured. There had been no rain or fog. As will be seen from the table, the dew-point at the surface of the water was well below the air-temperature. Similarly, no accession of water took place on the night of August 27–28, although again there was a heavy dew on the downs. The minimum reached on the grass was 43°. On the night of August 31—September 1, a measured quantity of water was reduced during the night by two-hundredths, the night being clear and cold, and the minimum on the grass being 37½°. Further experiments of a similar nature were constantly interfered with by the untoward nature of weather; indeed, throughout the summer useful work was frequently at a standstill from the same cause. On this night also opal-scale thermometers were placed on the grass, the dry puddle, and the wet puddle. On the first there was dew deposition on both upper and under surfaces of the opal, but in the case of the last two the dew appeared only on the under surfaces. In the case of that on the dry puddle, this shows that the dew was formed by the rise of vapour from the puddle itself, and thus, so far from puddled clay causing dew to be drawn out of the atmosphere, it actually parted with its own moisture without in any way feeding the pond. The puddle itself had not become moist.

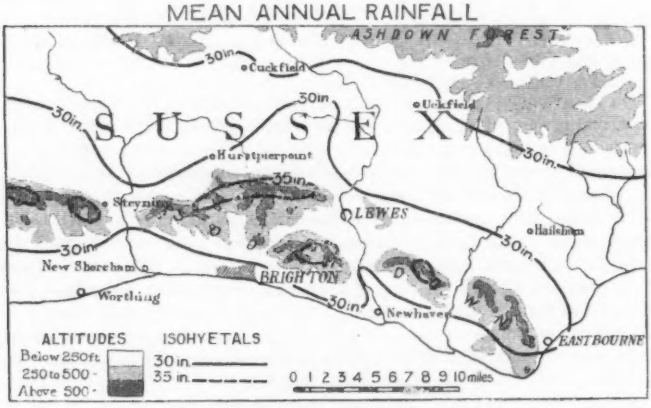
On the night of September 1, the same opal-scale on the dry puddle received dew on both upper and lower sides, but the puddle itself was hard and dry. On the night of September 7 a measured quantity of water from the pond was placed in a square tea-tray, so that the level of the water inside the tray was the same as that of the water of the pond on which it floated. On the morning of the 8th, after

a night of heavy dew, with a thick fog enveloping the downs till late in the morning, the measured water had increased by three-hundredths of its volume. There had been no rain during the period of the experiment.

Two measured quantities of water, placed similarly at 9 a.m. on the morning of September 9, were found to have lost by 6 p.m. ten-hundredths and twelve-hundredths of their volume respectively. The day was cloudless and sunny, the difference between the two being probably due to the shade of some high-growing weeds, which may have hidden the direct rays of the sun from one of the pans during a portion of the day.

It has been argued that the difference between evaporation and precipitation on the downs would be sufficient to account for the filling of the ponds by rain alone, on the ground that the rainfall on the downs is greater than in the valley below. My own experiments have not been made for a sufficiently long time to say that this is or is not the case. But during the period of my observation, there has not been a marked difference between them. The table opposite shows the amount of rain for 1909 on Clayton Down, at Clayton Rectory, at the foot of the hill, at Keymer, and at Ditchling, the latter two villages being a mile from the foot of the downs. The totals for 1909 were respectively 39·18 inches, 37·82 inches, 40·44 inches, and 36·73 inches. The next table shows the rainfall day by day for two months, the totals being not markedly different.

By the kindness of Dr. Hugh Robert Mill, I am able to reproduce a map



RAINFALL IN THE SUSSEX HILL-COUNTRY.
(*Contributed by Dr. Hugh Robert Mill.*)

showing the lines of average rainfall during the years 1868–1902, and this clearly demonstrates the fact that the higher the ground the greater is the average rainfall. Whilst it must be granted that rain is the chief source of pond-water, it is too irregularly spread over the year to prevent the ponds drying up frequently if this were their sole source of water. The average annual rainfall on downland has been shown by Dr. H. R. Mill to be 32·5 to 35 inches, the result of observations extending from 1868 to 1908. I know of no systematic observations in similar localities in regard to evaporation. Mr. Baldwin Latham has conducted experiments at Croydon on an evaporator consisting of a floating copper vessel, 1 foot in diameter,

Place.	O.D.	1909.											Total.
		Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	
	feet.													
Clayton Mill ... ... (top of down)	584	1·39	0·20	4·43	1·50	1·41	2·76	2·92	2·95	3·76	9·39	1·61	6·86	39·18
Clayton Rectory ... ... (foot of the down)	205	1·35	0·38	3·94	1·45	1·55	2·53	2·97	2·84	3·59	9·59	1·61	6·02	37·82
Ditchling ... ... (a mile north of downs)	220	1·32	0·43	4·72	1·50	1·53	2·81	2·94	2·69	3·16	8·66	1·61	5·36	36·73
Keymer ... ... (a mile north of downs)	145	1·31	0·55	4·39	1·65	1·46	2·82	3·43	3·86	3·75	9·29	1·37	6·56	40·44

July, 1909.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
Clayton Mill ...	—	—	0·15	0·06	0·14	0·21	0·05	—	0·20	0·18	0·07	—	—	0·05	0·10	0·16	—	—	—	—	—	0·02	—	—	0·19	0·12	1·21	—	0·01	—	—	2·92
Clayton Rectory ...	—	—	0·19	—	0·12	0·20	0·05	—	0·21	0·20	0·07	—	—	0·06	0·17	0·08	—	—	—	0·01	—	0·01	—	—	0·17	0·35	1·07	0·01	—	—	—	2·97
Ditchling	—	—	0·09	0·05	0·09	0·22	0·26	—	0·19	0·21	0·09	—	—	0·05	0·10	0·10	—	—	—	—	—	—	—	—	—	0·61	0·88	—	—	—	—	2·94

August, 1909.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total.
Clayton Mill ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·02	0·43	0·17	—	0·78	0·03	0·02	0·43	0·76	0·31	—	—	—	—	—	—	2·95
Clayton Rectory ...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·01	0·59	0·09	0·06	0·64	0·03	0·01	0·41	0·80	0·17	—	—	—	0·03	—	—	2·84
Ditchling	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0·53	0·11	0·03	0·58	0·06	0·04	0·32	0·80	0·20	—	—	—	0·02	—	—	2·69

in a tank of 4 feet internal diameter. We learn from a paper by Mr. P. R. Lowcock * that, owing to the construction of the various evaporators used by observers, many of the evaporation records are unreliable. That used by Mr. Latham seems to be accepted as the most reliable form used, although it may be suggested that, as the amount of evaporation depends chiefly on solar radiation and duration of sunshine, it is possible that the use of a copper vessel may affect the evaporation, especially when we compare the results with those which might be obtained from evaporation from the surface of a chalk or clay-puddled pond. However, the results obtained from Croydon, which, it may be added, have extended over thirty years, are the only ones comparable with evaporation from chalk downs, Croydon being on the northern verge of the Surrey chalk hills, although, I believe, the position of the evaporator was not actually on the chalk, but on tertiaries covering the chalk. The annual average amount of evaporation was here found to be 18·14 inches. There was also found to be an average annual amount of condensation of 0·36 inch. Taking the difference, namely, 17·78 inches, as the possible net amount of evaporation on the chalk downs, and the rainfall as 35 inches, we have a balance of 17·22 inches of rainfall which will go to feed the pond. This may be multiplied thrice in many cases, where the pond-margin is sufficiently hard and compact to prevent percolation, and where the margin contains twice the superficies of the central pond. In some cases the rainfall area has been found to bear an even greater ratio to the area of the pond. It must be confessed, however—and I speak from experience—that the lighter rains which fall on the margin do not reach the pond at all, the whole of the rainfall being soaked up. In such cases the rain which falls on the pond itself and its immediate margin alone goes to feed the pond. If a fine, light rain be continuous for some hours, this may, on the other hand, succeed in saturating the margin, and subsequent rain will run down into the pond. I estimate that even in the best made ponds not more than one-half of the total rain which falls on the margin ever reaches the pond. This is not easy of demonstration, but I give my opinion for what it is worth. In such a case, where the marginal area is twice that of the pond area, we must multiply the average rainfall twice instead of three times. Multiplying 17·22 by 2, we have 34·44 inches as the amount of rainfall which the pond would receive on an average in one year. Even with the draught which is made upon it by flocks of sheep and cattle, this would seem to be quite sufficient to prevent a pond from ever drying up. No doubt this satisfactory result would obtain if the rainfall were regularly distributed over the year. But it is not thus distributed, and the table for 1909 shows that it is most irregular in its distribution. On the other hand, evaporation follows certain regular curves, and the table in Mr. Lowcock's paper shows that at twenty evaporator stations there was a steady increase of mean evaporation from January to July, and a steady decrease thence to December. At Croydon it rose from 0·246 inch in January to 3·305 inches in July, with a regular decrease thence to 0·233 inch in December; and, as quoted by Mr. Lowcock from *British Rainfall*, 1901, the records at Camden Square and Atterbourne show that nearly nine-tenths of the total annual evaporation occurs in the summer six months. 'If it could be arranged that in these six months the greater proportion of the annual rain fell, we might expect that ponds would never dry up. Unfortunately, this is not the arrangement in nature, and yet it is rarely that a well-made pond, free of leakage, does dry up. And for this reason we must, I think, find a second recruit other than rain. This can only be mist and fog, or low-lying clouds, which come to the rescue, and make good the irregularities and inequalities of combined rainfall and evaporation.

* "Evaporation from Water Surfaces," *Association of Water Engineers.*

Some analyses of the water contained in certain of the ponds have been made by Mr. Wm. T. Burgess, F.I.C., and the results are given on p. 456. It will be useful to consider these together with those recorded in my former paper. Mr. Burgess remarks that "the analyses, taking them on the whole, are what one might expect from rain and surface waters after storage in open ponds on the chalk hills. You will note that the lowest chlorine figure, 1·0, was from the pond farthest from the sea. The point which has most interest to me is the fact that several of the waters contained carbonate of soda. In some cases the amount was small, but in two—Lewes Racecourse and No. 21—the proportion was quite marked. As far as I know, this is a discovery."

On June 6, after a good deal of rainy weather, it was particularly noticeable that the ponds numbered 1, 3, and 4 were remarkably low. Under the water of No. 1 pond large cracks could be seen, which showed that it had been dry probably for some weeks in April and May. Although raining heavily, no rain was running down the bank into the pond, the whole of the rain being lost into the puddle. This was true of all three ponds, and may demonstrate that they were leaking. After being cleaned out in September the water rose again, as shown in the description of these ponds below. There was a terrific storm on the night of July 9, and the rainfall was sharp and sudden. No. 1 pond had been empty for some time. Previous minor rains had little effect on it, but short and heavy rain had given it water, which measured about 10 feet across. This goes to show that heavy rains run off into the pond with little percolation. Some details of the various ponds which I have had under observation are appended.

No. 1. One Tree pond, overlooking Rag Bottom, 750 feet O.D.: Frequently dries up; very shallow trough; fed by runnel from track during heavy rains. Circumference of water-edge on June 28, 1908, 75 feet; on December 29, 1909, 104 feet, after heavy rains. The rain of the last three months of 1909 increased the areas of the various ponds enormously. This will be seen in the cases of other ponds as shown below.

No. 3. Potamogeton pond, top of Burnt House Bostel, 730 feet O.D.: analysis made; much weed and grass and *ranunculus* when first seen; cleaned out in September, 1909. Circumference of water, 142½ feet on August 23, 1908; 6 feet to grass bank; drainage from runnel only in heavy rains. Circumference on December 29, 1909, 165 feet, all the long grass in the pond being covered.

No. 4. Grass pond, south-east from No. 3, overlooking Home Bottom, 716 feet O.D.: analysis made; much grass in pond and reeds round edge when first seen; grass almost to water's edge; cleaned out September, 1909. Shingly soil; no drainage from road except in heavy rains. A breeding-place for May-flies. The cleaning of this and No. 3 pond evidently stopped suspected leakage, and on December 29, 1909, the circumference had increased to 138 feet.

No. 5. Ditchling Beacon, top of Ditchling Bostel and overlooking Big Bottom, 750 feet O.D.: Seaford Cliff seen in the south-east; some tufts of reeds growing in pond, which would be good for dew; many newts and *limnæa* and *planorbis* snails; a chalk-puddled pond. This pond is at the head of a long winding valley, and has not been known to run dry. At times of heavy rains there is probably much drainage from the chalky road. The water is very clear. Many dragon-flies; some sludge in pond. On December 29, 1900, all the reeds were covered by the water, and the surface had encroached on the grass bank. The circumference was 245 feet.

No. 6. High Park Corner, near, 620 feet O.D.: A large pond of very clear water; chalk-puddled; water-edge marked by a ridge; no weed projects above surface; on summit of down. Circumference of water, 227½ feet on August 12, 1908; 20 feet to grass bank.

POND WATERS.

RESULTS OF ANALYSIS EXPRESSED IN PARTS PER 100,000.

	No. 3 pond, near No. 4.	No. 4 pond, near Burnt House Bostel.	No. 13 pond, over North Bottom, near Heathy Brow.	No. 17 pond, Upper Standean (received Aug 11, 1909).	No. 18 pond, Ewebottom hill, Patcham (received Aug. 11, 1909).	No. 21 pond, Piddingworth, 580 feet (received Aug. 16, 1909).	No. 22 pond, Greystones, 620 feet (received Aug. 16, 1909).	No. 29 pond, Shambledean Bottom, 350 feet (Aug. 22, 1909.)	No. 30 pond, Stanmer down (concrete), Sept. 7, 1909.	No. 12, Cemented pond, south-west from Lewes Race-course, 390 feet.	Riddlesdown pond, Surrey (Aug. 25, 1909).
Total solid residue ...	16·8	19·3	16·6	18·5	30·90	45·2	36·7	36·8	41·4	43·9	25·7
Oxygen consumed (4 hrs. 80° F.)	0·276	0·542	0·304	0·58	0·768	—	—	—	2·4	0·511	0·36
Nitrogen as nitrates ...	0·037	trace	trace	0	0	0	0	0	0	trace	traces
Nitrogen as nitrites ...	0·005	0·02	0·01	0	0	0	0	0	0	0	0
Chlorine	1·8	2·8	1·75	2·0	3·2	8·7	5·55	2·8	4·5	1·7	1·0
Total hardness	*7·3	*8·7	*9·4	10·0	8·6	16·3	16·6	14·0	12·7	2·7	15·6
Lime (CaO)	4·1	5·1	5·4	5·9	4·9	—	—	—	—	1·6	—
	Very turbid.	Turbid.	Slightly turbid.	Turbid. Hardness all due to carbonate.	Turbid (contained small amount of carbonate of soda). Hardness all due to carbonates.	Very turbid and dirty water. Carbonate of soda, 13·0. Hardness all due to carbonates.	Very turbid and dirty water. Carbonate of soda, 3·7. Hardness all due to carbonates.	Very turbid and dirty water. Carbonate of soda, 5·0. Hardness all due to carbonates.	Very turbid and dirty water. Carbonate of soda, 2·4. Hardness all due to carbonate.	Turbid. Carbonate of soda = 14·3.	Slightly turbid. Two-thirds of hardness due to carbonates.

* Hardness practically all due to carbonate of lime.

No. 7. Red-worm pond: A very foul clay-puddled pond; mud permeated with errant red-worms; much surface drainage from soil; on side of hill; many rushes in pond; puddled with red loamy clay.

No. 8. Bushes pond: Clay-puddled; water not clear; fed by drainage from field, and dew from overhanging trees and bushes; near No. 7.

No. 9. Waterhall valley, over, 400 feet O.D.: A beautiful pond, comparable with No. 6; water very clear; little, if any, drainage from down; weed beneath surface. Circumference of water, 260 feet; 15 feet to edge of grass ridge on September 13, 1908.

No. 10. Oblong pond, 720 feet O.D.: puddled with white loamy chalk; margin covered with angular flints; the shape is unusual, the dimensions being 50 feet long, with an average breadth of 25 feet, on September 6, 1908; 147½ feet in circumference. A good deal of weed beneath the surface.

No. 11. Circular pond, near to 10, 720 feet O.D.: very shallow; much reduced in drought; comparable with No. 1. Circumference, 140 feet on September 6, 1908. Pond-weed under surface.

No. 12. Cemented pond, on the Bulmer down, 390 feet O.D.: analysis made.

No. 13. Chalky pond, near North bottom, on slope of hill, 570 feet O.D.: 117½ feet in circumference; water very clear; margin of smoothed white chalk. Not on summit of down; analysis made.

No. 14. Rottingdean, near Old Mill: dry many years; covered with grass; on highest ground of neighbourhood. An old stone-breaker stated that he had never known this pond to have contained water. He had served in the Baltic Fleet in Crimean days, and had settled in the neighbourhood soon afterwards.

No. 15. Rottingdean, north-west of: dry, and overgrown with grass; a clay-puddled pond.

No. 16. Rottingdean, north-east of: a cemented pond; circumference (July 8, 1909), 130 feet; 13 feet across margin; water foul, receiving drainage from farmyard.

No. 17. Upper Standean, 560 feet O.D.: Water clean; chalk-puddled; analysis made. Circumference of water, August 14, 1809, 160 feet; chalky margin, 16 feet across. On December 29, 1909, the circumference had increased to 206 feet, and the margin had decreased to 12½ feet across.

No. 18. Ewebottom Hill pond, 450 feet O.D.: Circumference of water on July 14, 1909, 165 feet; 20 feet across chalky bank; hard puddle. Two well-defined ridges round pond at 5 feet and 9 feet from water's edge, showing limits of former extensions of the pond. A dry runnel on north-east side, but grass-grown; quantity of pond-weed under surface, with eggs of fresh-water snails. On December 29, 1909, the circumference had increased to 201½ feet. Analysis made.

No. 19. South Hill, Pangdean, 550 feet O.D.: Dry; concreted, but concrete broken up. Concrete made of fine gravel and occasional shell-fragments, about ¾ inch thick.

20. Over Donkey Bottom, Standean, 400 feet O.D.: dry; a well-made pond, on side of hill.

No. 21. Piddingworth, 580 feet O.D.: Analysis made; water green with algæ; water not clean, very green; much used by cattle. Circumference of water, 170 feet on August 8, 1909; 15 feet across white-puddle margin. Analysis made.

No. 22. Greystones pond, 620 feet O.D: Analysis made; circumference of water on August 1, 1909, 95 feet; weeds almost to water's edge; large crater-like trough; surrounded by large masses of Tertiary sandstones (*sarsens*)*; much pond-

* *Knowledge*, February, 1910.

weed and grass in water. Circumference on December 29, 1909, 122½ feet; water's edge to rise of bank, 22½ feet.

No. 23. Plumpton plain, 680 feet: Dry; overgrown with grass.

Nos. 24–26. On Bulmer Huff, 500 to 530 feet O.D.: All dry and overgrown.

No. 29. Shambledean Bottom, 350 feet O.D.: Analysis made; circumference, 77½ feet on August 22, 1909; 15 feet across margin; much drainage.

No. 30. Stanmer Down, 430 feet O.D.: No runnels; analysis taken; 112½ feet in circumference on September 4, 1909; 20 feet across margin. This is a carefully concreted pond, apparently kept watertight by constant repairs; on the summit of the down.

No. 31. High Park Wood: pond dry September 7, 1909; 500 feet O.D.; 63 feet bank to bank. In centre of pond is a perforated pipe projecting about 1 foot, from which the water collected is made to flow to a farm lower down.

No. 32. Pyecombe Golf Links: pond dry September 8, 1909.

Next to rain as the chief means by which the ponds are filled we may safely place mist and fog, especially as regards those ponds which are at the very summit of the hills, where the condensation resulting from altitude is greatest. We have seen that the quantity of sodium chloride in the ponds is large. I think much of this may be attributable to its precipitation therein as the nuclei of mist-particles. In the early morning I have seen the mist gradually forming, not only in the valleys, but on the hills. Not always do they creep up the valleys from the sea, as has been alleged. If that were the case, I am afraid many of them would disappear in the rising sun before they reached the escarpment. Charged as the atmosphere always is with particles of common salt and other salts, the chills of early morning requisition these particles as the carriers of condensed aqueous vapour, by reason of their affinity for moisture, and when the mist is on the move, as it almost always is, much of the mist and salt-particles is mechanically deposited by gravitation in the ponds as the mist passes over.

It is an interesting subject for discussion as to whether the electrical condition of the atmosphere has anything to do with the deposition of aqueous vapour on the surface of ponds. It is now thought that the air is charged with electrons ejected from the sun, the negative corpuscles being drawn, as suggested by Sir Oliver Lodge, towards the poles by the Earth's magnetic field, leaving the Earth positively electrified, and as the vapour rises out of the soil after nightfall with radiant heat, it conveys with it a charge of positive corpuscles.

The theory that the atmosphere owes its electricity to the evaporation going on from masses of water, as propounded by Exner, is no longer tenable, in view of Prof. G. Tchwalbe's experiments on the subject. He found that the rising vapours from electrified fluids carried no electricity with them, and consequently the theory of the conveyance of the electric charge of the Earth to the air by means of evaporation must be discarded.*

Can it be that this electrical condition of the atmosphere contributes to the filling of the ponds? Fog is usually in a high state of electric tension. Every fog-particle is charged, and, in accordance with the well-known law the electrical tension is greatest on the surface of each particle. The immediate surface of the Earth over which it floats becomes electrified in an opposite sense, and as the tension increases there is the tendency for the fog-particles to be discharged. As the union of rain-drops in a cloud into larger drops preparatory to their falling results in greater electrical potential on the larger drops, and this accumulates until a flash of lightning relieves the tension and the rain falls, may there not be a

* *Nature*, April 5, 1900.

similar action taking place in the mist-particles? The dense fogs of the Downs are caused apparently by the fact that (1) the dust nuclei are comparatively few on these heights, and (2) a large proportion of these are salt particles. On account of each of these circumstances the particles become gorged, so to speak, with vapour, and drench clothing and vegetation with moisture. The particles are heavily laden, and roll into any and every depression, or, if arrested by a clump of trees, will deposit their moisture thereon or thereabouts. The fall of rain from a cloud is a consequence of electric discharge. The fall of fog-particles is in the same way the consequence of the discharge of their electricity, but the particles, being portions of a cloud in contact with the earth or pond, would discharge gradually and without any sudden and visible discharge, such as would take place in the case of an electrified cloud.

The downland heights are rounded and free from angular protuberances such as would tend to dissipate the electrical discharge into space, and they would seize upon a fog or mist as means of carrying off their positive charge. Given a period of fine weather, free from fog, and there is no means of escape of the electrical potential of downland except in the relief afforded by a thunderstorm.

Dr. Schliep, of Baden-Baden, as a result of numerous observations, has found that atmospheric electricity is generally positive, but that if the sky is covered, the potential decreases or shows variations, and it is from time to time negative. The positive potential is usually higher and more regular during the night than in the day-time, there being a minimum by day and maximum by night, that is, only one daily period.*

Mr. C. T. R. Wilson finds that positive and negative ions differ in their power of acting as nuclei of condensation, the negative ions being more efficient, and that as a result a preponderance of the latter will be carried down to the Earth's surface by precipitation, leaving the air positively electrified.†

Dr. John Aitken has pointed out that dust-particles will form nuclei when the atmosphere is saturated, or even when the air is not quite saturated, whereas ions, whether negative or positive, require a degree of supersaturation before they can act as nuclei. In order to obtain a supersaturated atmosphere it is necessary that we should have a dust-free atmosphere, and if there is not such a thing as a dust-free air to be found, then there can be no such thing as the supersaturated air requisite to bring about the separation of positive and negative ions. Dr. Aitken states that "it can hardly be said that there is such a thing as dust-free air." ‡

Mr. C. T. R. Wilson, however, maintains the theory that the well-known positive electrification of the atmosphere is due to the superiority in efficiency as nuclei for the condensation of water vapour of the negative ions over the positive, thus causing the precipitation of the negative ions.

It has been pointed out by Prof. J. J. Thomson that if positively and negatively charged ions respectively require different degrees of supersaturation to make them act as nuclei for the condensation of water-vapour, this may be a source of atmospheric electricity. Mr. Wilson has proved by experiments that he has made that water-vapour does condense much more readily on negative than on positive ions, and sufficient evidence has been brought forward to prove the existence in the atmosphere of free ions. He thinks that the necessary degree of supersaturation can actually occur in an elevated dust-free layer, and thus the positively electrified normal condition of the atmosphere is the result.

Mr. A. Marshall endeavoured in 1900 § to explain the precipitation of fog-particles

* Quoted by John Perry in *Nature*, March 25, 1900.
† *Nature*, March 1, 1900. ‡ *Ibid.*, March 29, 1900.
§ *Ibid.*, September 20, 1900.

into dew-ponds by a difference in potential between the particles of moisture and the hill-summits on which the ponds are situated. He thought that owing to this difference of potential the particles would be attracted to earth, and presumably also to a pond. His experiments were not, however, performed over water, and I think that the normally positive condition of fog is sufficient, by induction, to justify a belief that its particles will be naturally drawn to earth and finally discharged there, and, seeing that it is always more or less on the move, every pond that it meets will benefit.

In conclusion, I have again to express my indebtedness to the Royal Society for a Government grant which enabled me to pursue my investigations into this fascinating subject.

I commenced my observations on this subject with a leaning towards the theory that many downland ponds were dew-ponds; that is, that they were replenished principally from dew. I confess I should have wished to have been able to prove to you that dew was an important factor in filling the ponds. But I have been led to believe otherwise, and I retract anything which I have said in this direction as having been founded on insufficient data. Very rarely, indeed, does dew ever form on the surface of ponds, and rarely, I believe, on the puddled margins; and if we continue to use the term dew-pond, we must remember that the word must be used here in the widest sense as including any form of condensation out of the atmosphere. Rain is undoubtedly the all-important replenisher of these, as of all ponds which are not fed by springs. It is almost with a feeling of regret that I abandon the theory of dew-filled ponds. The mystery surrounding the quiet invisible formation of dew has a fascination for me, as for most people, but the results of greater knowledge must prevail, and the dew which waters our downland grass and the corn on our dry flint-bestrewed downland fields cannot longer be held to have any important bearing on the "mystery," which is no longer a mystery, "of the dew-pond."

Dr. STRAHAN: We have to congratulate Mr. Martin on having brought to a conclusion—a temporary conclusion only, I hope—an investigation on which he has been engaged for a couple of years. He has done a great deal of work, some of which must have involved no little hardship in the performance. Whether we shall all agree with the conclusions at which he has arrived, I would not venture to say, nor how much work remains to be done, but I invite discussion in the hope that both these considerations will be taken into account.

Mr. W. T. BURGESS: I think I have very little to add to what Mr. Martin has quoted from the letter I wrote to him, concerning the water analyses I made to assist him in his investigation. The extraordinary thing was the presence of carbonate of soda in some of the samples. Carbonate of soda is found in well waters, obtained from the Chalk beneath the London Clay, and also from some other calcareous formations covered with impermeable strata. I refer those who are interested in alkaline waters to the papers of W. W. Fisher, in the *Analyst* for 1901 and 1902. The carbonate of soda found in the pond waters was, in all probability, formed by the slow reaction of carbonate of lime, with the silicates containing alkalies, which were present in the soil and mud accumulating in the beds of the ponds. It is perhaps worth noting that I recently found a small but distinct quantity of carbonate of soda in a sample of water taken from a chalk percolation gauge, the sample representing the first water that had passed after a long period of no percolation.

Dr. J. S. OWENS: There is a point to which I should like to refer. It appears to me that Mr. Martin is not giving the rain credit for all that it can do. Referring to the water-supply due to rain, Mr. Martin says, "This may be multiplied thrice

in many cases, where the pond-margin is sufficiently hard and compact to prevent percolation, and where the margin contains twice the superficies of the central pond." Now, it seems to me that from such a margin, which is twice the area of the pond, you get in the pond approximately 35 inches rainfall multiplied by 2, and on the pond itself another 35 inches, and the only loss would be the evaporation from the pond surface, approximately speaking. The rain which would fall on the margin, it being very narrow, would run into the pond at once, so that there would be very little loss. This would give a figure of 35 multiplied by 3, minus 17·78 loss by evaporation from the pond, which I make to be 87·22 inches, or, in another form, $35 \times 2 + 17{\cdot}22 = 87{\cdot}22$, and that is something like five times the quantity of rain which the pond surface alone would account for instead of three times. Further down this sentence occurs: "I estimate that even in the best-made ponds not more than one-half of the total rain which falls on the margin ever reaches the pond. That is not easy of demonstration, but I give my opinion for what it is worth. In such a case where the marginal area is twice that of the pond area, we must multiply the average rainfall twice instead of three times." I make out that you must multiply it about three times, on the same reasoning; that if the rainfall is roughly 35 inches, then the amount of water which the pond would get from the margin in this case would be 35 multiplied by 2 and divided by 2 for percolation, plus 17·22—the balance which the pond alone would ordinarily get—and that is 52·22, and not 34·44, or $\frac{35 \times 2}{2} + 17{\cdot}22 = 52{\cdot}22$, which is something like three times the amount it would get without margin, instead of twice. I raise the point because it seems to have a considerable bearing upon the final conclusion. If the author's conclusion is that rain is sufficiently important to explain the ponds, it must be of even more importance than he gives it credit for, and so strengthens his conclusion.

Captain T. H. Tizard: I would like to suggest one point with reference to these conclusions, a quite simple one, namely, the reason there is more dew on the land than there is over the pond. In the one case the radiation from the earth, being considerable, causes a low temperature which collects the moisture from the warmer atmosphere, whereas the radiation from the pond, whilst it cools the water on the top of the pond, causes the colder water to sink to the bottom, and the warmer and lighter water to rise; therefore the surface water is never as cold as the surface land is. The radiation from the surface of the pond is nothing like the radiation from the earth, therefore the air that is in contact with the water of the pond does not deposit the dew on it. I do not know whether that has been explained before, or anything else about it, but it struck me as a point that might be brought forward.

Major Darwin: I understood that the measurement of the rise of the water when the fog fell on the pond was done by watching the rise on the stick. I should like to know what Mr. Martin thinks of the possibility of adopting a more accurate method of estimating the height of the water. The best plan would be, I suggest, a screw touching the surface of the water, a method by means of which extremely accurate measurement can be obtained.

Captain Wilson Barker: I should like to join in the thanks to Mr. Martin for his interesting paper on "Dew Ponds." In some districts such ponds would be very useful. The formation or maintenance of these ponds seems to be controlled a good deal by the formation of the soil, and it appears as if they were formed only on the Chalk. I share Mr. Martin's disappointment in his conclusions that these ponds may not after all be "dew" or "mist" (as I should prefer to call them) deposits, but are kept going by rain. I hope that further investigation may be

undertaken, as I do not think it is even yet settled. I think, perhaps, valuable assistance might be obtained from practical agriculturalists. Meanwhile, we owe Mr. Martin our hearty thanks for his painstaking labours and his most interesting series of papers.

Mr. S. SKINNER: I should like to congratulate Mr. Martin on the scientific spirit with which he has carried on his experiments, although it must have been somewhat hard to have to come to the result that he has; but it is a result which I have been forced to accept for a long time, namely, that it is rain which fills these ponds. I was very much interested this year, when walking about on the Southern Downs, to find that casual labourers and field men I asked how the water got in the ponds invariably told me that it was rain. I also met with the same answer in another part of England.

But still I have felt that there is an opening for some one with sufficient perseverance to actually separate the amount of dew which forms from the rain and mist which falls. I think there is an opening to measure this, and last year some little step was made towards this. I have adopted a vessel which is eminently suited for dew formation; that is to say, I have taken one of Sir James Dewar's vacuum vessels—vessels with a double wall, in the form of a champagne-glass, which many of you may have seen at the Royal Institution used to hold liquid air, and which have the remarkable property of very small heat transmission. This makes it an excellent vessel to form such a pond, and taking such a vessel and enclosing it suitably in a box with an open top, a friend of mine was kind enough to make observations in August and September on every dewy night, and he estimated the amount of dew in the same way as you estimate rain, that is, the number of inches on the area of the ground, as carefully as he could, and then made the assumption that the experiment was conducted for a whole year. It is, of course, an assumption, because there are months in which there is practically no dew. Doing this, we found that the amount for the whole of the year does not amount to an inch; that is to say, using the best conditions for the formation of dew, we did not get more than an inch of water. Of course, that is nothing compared with the rainfall. I hope shortly to put those figures together and to publish them.

Coming to the question of mist, which is the next source which Mr. Martin has discussed, I should like to remark that I do not think you can get much water collected out of mist through its simply falling by the action of gravity, for the velocity of fall of mist particles is very small. I think that the chief way in which mist particles are collected is simply by direct entanglement. If a mist blows against a body, the particles are thrown against it, and caught by direct entanglement, so that I would not look to falling by gravity as the agent for filling a pond from mist. As to the electric phenomena to which Mr. Martin has alluded I really feel there we have much to learn. One thing I think we can at once take warning about is, that we must be very careful to distinguish the new electric views from the old ones, and I did not think Mr. Martin had done so. I hardly like to go into that matter without taking the paper and going through it very carefully, but I do not feel that there is much hope of bringing the fog particles on to the pond through just an ordinary electric attraction which was alluded to. I should like to repeat my congratulations to Mr. Martin, and to say how much I admire the scientific spirit with which he has given up a view which he favoured, for the one which I think must now be adopted.

Dr. WILLIAM MARTIN: I can scarcely hope to add anything which is of utility to this long series of observations which have been made by Mr. Martin during the last and previous years. Reference has already been made to his extreme industry.

He has not mentioned it himself, but I think I ought to allude to the fact that on one day he erected a tent in order that he might be present and lie awake the whole of the night to take hourly and half-hourly observations. We are not here this afternoon to discuss the formation of these ponds, but I could not help remarking, as I saw those slides which were shown us, of the care that was taken by the local agriculturist to preserve a clean edge on the margin of the ponds. In every pond with which I am acquainted that was holding water, the edge of the margin had been carefully cleaned in recent years. Evidently in the minds of the people on the spot, the extent and cleanliness of the margin had a great deal to do with the amount of water that the pond would hold. As regards the cattle passing through a pond and spoiling the straw, as I understood a previous speaker to remark, that, of course, entirely depends upon the question whether there is any straw there or not to spoil. I have had many conversations as regards the question of straw with a good many people on the South Downs, and none of those to whom I happened to speak had used straw, or had heard of its employment. I think one of the most important results that is to be obtained from this paper is set out upon page 444, where we find: "during the hours of possible dewfall the temperature of the surface air was, with but one exception, always lower than that of the surface water, and on no occasion did that of the water approach dew-point." That should give the death-knell to the theory that, the water in the pond being colder than the air, the temperature of the layer of air in contact with the water is diminished, and the air thus caused to deposit its moisture as dew, and so enrich the total quantity of water in the pond.

One great advantage of a paper like this is that it should put an end to arm-chair theorizing upon natural phenomena. There has been far too much of that, especially in connection with dew-ponds. I feel sure that if anybody now comes forward to discuss any theory that he may have as to dew-ponds, he must either have repeated this laborious work of Mr. Martin, or he must have digested the tables which are here so well set out. It is a feature of the paper that Mr. Martin has not hesitated to put down the results of his observations, so that other people may see the basis of his conclusions and agree or disagree with him as the case may be. Allusion was also made to the idea that Mr. Martin should continue his experiments upon this enticing subject. I feel quite sure Mr. Martin would do so on one condition, and it is a pecuniary condition. All these experiments and observations take up not only a large amount of time, but considerable expense is also attaching to them, and that expense must be met out of somebody's pocket. In this case it was due to a Government grant through the Royal Society.

Dr. STRAHAN: Unless any one else wishes to make any remarks, it merely remains for me to read some questions which Dr. Herbertson has left behind with me, with an apology that he was himself obliged to leave. He asks, "Was there dew on any inorganic matter? How far is 'dew' on plants due to transpired water from the inside of the plants, and how far to deposition of atmospheric moisture? Were the dry and wet bulbs ventilated? In calm weather the ordinary wet bulb is of hardly any use—it must have air drawn past it or be swung through the air."

For my own part, it seems almost ungracious to ask one who has done so much if he cannot do a little more, but it seems as if there was room for further precise observations on the fluctuations in the water-level. There are forms of apparatus which will enable exceedingly minute variations to be detected. Observations of that description, accompanied by simultaneous notes on the character of the weather, might be taken during bright and cloudy summer days, during clear and misty nights, and under various climatic conditions. It would be most

important to determine what fluctuations, if any, were shown under those varying circumstances. A few years ago, the existence of trees hanging over dew-ponds was insisted upon by several writers on the subject as a *sine quâ non*, and there can be no doubt that, under certain circumstances, this must help in collecting water; the fog, as it is blown past, settles upon the branches to such an extent that, although there may be no rain falling, the effect of a heavy rain is produced. I do not know that any mention of that matter appears in the paper. I will now ask Mr. Martin to reply to the various questions which have been raised in the discussion.

Mr. E. A. Martin: I am very much obliged to you for the way in which you have received my paper. There is a great deal of work yet to be done, and what I do want to do in the future is something in the nature of those precise experiments as to variations in the surface-level of the water. I should like to say, however, that I did not measure the evaporation or condensation in those few experiments that I made merely by measuring the rise and fall of the water on the stick, but by means of measured quantities of water in little square trays, as mentioned in the paper. I should like to say at once that a number of the points which have been touched on this afternoon I dealt with last year, and for the sake of brevity I did not repeat them. One point mentioned was the question of puddling by cattle. I particularly dealt with that last year, and gave particulars of some evidence I obtained from the Downs. Mr. Bennett suggested some years ago that puddling by accident may have been the origin of the idea of the sheep-ponds; that is to say, for instance, on the top of Cissbury there is a good ditch all round the greater part of the camp. Water would fall therein, and cattle would puddle it when they went through the openings in the vallum, and in a very short time there would be natural puddling which might give rise to a pond there. That may be a natural cause, in the first place, of the idea of a pond having a puddled bottom; but of course that is only theory. Another matter referred to is that the deposition of dew on grass is more than that which falls on the water. I think I have dealt with that; I am strongly of opinion that such is the case, particularly from the fact that so seldom does the water become reduced in temperature to dew-point or below. The formation of dew on the grass is quite a different matter to the formation of dew on water. Grass may be wringing wet, as it frequently is on the downs, and yet the water is comparatively warm. In regard to Mr. Skinner's remarks with reference to his own experiments, I sincerely hope that we shall see the result of the observations that have been made. One gentleman referred to an incident that, when he asked of certain men as to how the water got on the Downs, they said of course it was rain. Well, you have got to have an impervious bottom to your ponds before you can hold the water that does arrive there. With regard to the foundations of such ponds, I do not want to say that a dew-pond could not be made, although I think these ponds that we have seen are not dew-ponds; all I say is that farmers with the means at their disposal will not be disposed to spend very great sums of money to make them really dew-ponds when they can get mist- or rain-ponds. But I have not the slightest doubt that you can induce a precipitation of dew by keeping the water cold. I do not know why you should not have such an arrangement as one finds in a thermos flask—then possibly you might have a proper dew-pond. But farmers are not going to this expense when by ordinary means they can get ponds which are satisfactory from their point of view. I think I have taken up most of the points that need be answered. I have noted other points which I shall certainly take up in the future when I have an opportunity. As Dr. Martin said, it is a question of expense, and I was considerably helped by the grant with which the Royal Society kindly furnished me.

GEOGRAPHY AT THE BRITISH ASSOCIATION.

By E. A. REEVES.

WHATEVER may be the general opinion of the recent meeting of the British Association, which, after an interval of thirty-one years, was again held at Sheffield this year, so far as Section E (Geography) is concerned it will perhaps be remembered as one of the most successful of recent times. The attendance was above the average, and in nearly all instances the papers and lectures were quite up to the usual standard as regards geographical value and interest, if indeed they were not of a higher order of merit than they have been occasionally in the past.

The section was so fortunate as to have the lecture hall of the Firth College allotted to it for its meetings, and a more suitable place could hardly have been found, both as regards its general accommodation and acoustic properties. Dr. A. J. Herbertson, Professor of Geography at Oxford University, was the president of the section, and he was supported by Col. Sir Duncan A. Johnston, Mr. G. G. Chisholm, Col. H. W. Feilden, Mr. J. Bolton, and Mr. J. Howard Reed, as vice-presidents; and by the secretaries, Rev. W. J. Barton (Recorder), Mr. E. A. Reeves, Mr. J. McFarlane and Dr. R. N. Rudmose Brown. Valuable help and advice was also rendered by a strong committee of geographers consisting of: Dr. Tempest Anderson, Mr. H. O. Beckit, Col. Bigg-Wither, Mr. D. G. Hogarth, Prof. J. L. Myres, Capt. E. Dubois-Phillips, Dr. Hamilton Rice, Major L. Forbes, Dr. J. W. Evans, and Capt. Henrici.

Before the real work of the various sections commenced a question arose at the first meeting of the general committee, resulting from a suggestion of a tentative nature placed on the Report of the Council of the Association, as to the desirability of combining Sections C (geology) and E (geography) in one section of two departments. This came as a great surprise to many, but it seems to have been a part of a scheme under consideration for the rearrangement of several sections. The matter was not discussed at this first meeting, but postponed to the second, held on the Friday afternoon, when an amendment, proposed by Prof. A. J. Herbertson, and seconded by Prof. A. P. Coleman, the president of the geological section, to the effect that the two sections should remain distinct as before, was pu to the meeting, and carried by an overwhelming majority, much to the satisfaction of both geologists and geographers present, who failed to see any reason for the suggested alteration. It was very properly pointed out that while there were occasions when these two sections, as others, might with advantage meet together and discuss some subject in common, these were exceptional, and in general the points of view and matters for consideration were entirely different, and there could be but little in common between the two.

The Geographical Section commenced its meetings on Thursday morning September 1, and naturally the first business was to listen to its president's opening address. As this is published in the present number of the *Geographical Journal*, it is unnecessary to refer to it at length here. Its theme, "Geography and Some of its more Pressing Needs," was certainly an important one, and probably there could not have been found a better exponent than Prof. Herbertson. It is, of course, difficult to deal with so extensive a subject, and one upon which there has been so much discussion, at all adequately in the space of one hour, but whatever may have been thought of some of the opinions expressed, or suggestions brought forward, it was obvious that the address was listened to with great interest by many whose business it is to teach geography, and who are endeavouring to do this on the more enlightened and up-to-date lines.

Immediately following the president's address a paper was read by Dr. J. D. Falconer on the origin of some of the more characteristic features of the topography of Northern Nigeria, which consisted of a very successful attempt to give a general idea of the river systems and other topographical features of this remarkable region of West Africa. The author has made a special study of this subject, and spoke from his own personal observation and experience. The hydrographical centre of the Protectorate, which comprises an area of about 255,700 square miles, is the Bauchi plateau, rising to a height of 4000 to 5000 feet, and the rivers belong to two great systems, the Niger-Benue and the Chad or desert system, and the origin and characteristic features of each of these was briefly dealt with. Probably this paper, when amplified, will be published later on in the *Geographical Journal*. The first morning's meeting closed with two short addresses by Prof. W. S. Bruce, in one of which he gave an account of his latest surveys and explorations in Prince Charles Foreland, Spitsbergen, and the other an outline of his plans and the route proposed for his forthcoming Antacrtic expedition. The latter of the two doubtless created the greater interest, as was shown by the fact that although it was past the luncheon hour when he commenced, many stayed in the hall to listen to it. The programme is certainly an ambitious one, but he is, no doubt, wise in attacking the South Pole from a new base, that of the Weddell sea, and if he is ever successful in crossing over from this side and meeting his relief party coming from the better known Ross sea side he will have accomplished one of the most remarkable achievements of polar exploration. Even if this proves impossible, it was the general impression that there seemed a greater chance of doing good scientific work from the Weddell sea base than perhaps any other.

In the afternoon of this same day, a most interesting lecture, which Prof. Bonney the President of the Association attended, was given by Captain J. K. Davis on the research work undertaken by him in the *Nimrod*, during the voyage from Sydney across the low latitudes of the far South Pacific *viâ* Cape Horn to Montevideo. According to instructions given him by Sir E. Shackleton, attempt was to be made to locate the positions of certain islands marked on the charts, but the positions or actual existence of which were doubtful. These islands were the Royal Company islands, Emerald island, Nimrod islands, and Dougherty island. The voyage lasted from May 8 to July 7, 1909, and proved a most interesting one. The story of the visit to Macquarie island, which was called at on the way, and of its solitary Robinson Crusoe like inhabitant was quite fascinating. Popular accounts of this have appeared before, and the real value of Captain Davis's lecture was the description of the search for the supposed islands, the method of taking the soundings, meteorological observations, and the gales and tremendous waves encountered. All this was told in a straightforward sailor-like manner, which together with the excellent lantern slides, exhibited for the first time, held the attention of a numerous and appreciative audience. As a result of this voyage it is more than doubtful if some of these islands exist, and of the Royal Company islands, the Nimrod islands, and Dougherty island it may certainly be said that they are not in the neighbourhood of the positions assigned to them hitherto, and may probably be safely taken off the charts altogether.

The morning of Friday, September 2, was given up to a joint meeting with the Geological Section, and some important papers were read dealing with subjects in which both geographers and geologists are interested. These were as follows: Mr. C. Johns, on the Geology of the Sheffield District; Prof. A. McWilliam, on the metallurgical industries in relation with the rocks of the same district; Mr. T. Sheppard, on the Humber during the human period; Dr. Tempest Anderson, on Matavanu, a new volcano in Savaii (German Samoa); and the Rev. E. C. Spicer, on

the present Trias condition in Australia. Although perhaps more strictly geological than geographical, the first two papers, and especially the second, had a very direct bearing on the economic geography of the district of England concerned. Mr. T. Sheppard, whose investigations are being carried out in connection with the Research Department of this Society, gave a clear account, illustrated by a series of lantern slides of old maps and charts, of the changes that have taken place near the mouth of the Humber from the earliest times of which we have any record. Dr. Tempest Anderson's paper, or rather lecture, of which excellent lantern slides were a special feature, consisted of an account, given in his usual graphic style, of a visit he recently paid to the Pacific islands, during which he had the opportunity to witness the birth of a new volcano.

At 2.30 in the afternoon of this day, Dr. Hamilton Rice lectured to a fairly numerous audience on his recent journey in South America from Bogota to Manãos *viâ* the river Uaupés. The description of the aborigines, or so-called Indians, inhabiting the banks of this little-known river, and their customs, rites, and mode of life, formed a specially interesting feature of the lecture, but as an account of this journey, with a map, was given in the *Geographical Journal* for June last, it is unnecessary to go into detail here.

On the following Monday morning, when the section reassembled, after the week end devoted to excursions and rest, Mr. J. Howard Reed read a paper on "Cotton growing within the British Empire." This was one of considerable importance, and dealt with a subject of vital interest to thousands, specially in the Lancashire district. It showed that year by year a serious crisis is being gradually approached, owing to the regular and progressive shortage of cotton, and the absolute necessity of opening up fresh sources of supply, if possible, within the British Empire. Egypt and India up to the present have been the only substantial sources which has supplemented the production of the American cotton fields, but during recent years considerable progress has been made with the cultivation in newly developed regions. The lecturer then gave a brief account of the work and objects of the British Cotton Growing Association in which he is interested, and finally mentioned what he considered to be the most likely parts of the Empire from which the future supply of cotton will be obtained, referring specially to the West Indies, Uganda, Nyasaland, Lagos, and Nigeria. Although considered by some present to be somewhat too pessimistic in his opinions of the future of the cotton industry in this country, all were agreed as to the importance of this subject, and it is satisfactory to learn that the lecture will be printed and widely distributed amongst those specially interested.

Mr. Reed was followed by a paper on the region of Lakes Albert and Edward and the mountains of Ruwenzori, by Major R. G. T. Bright, whose recent work in connection with the boundary survey in this region of Africa is well known. This paper was illustrated by a series of excellent slides. A lecture covering much the same ground, but more detailed, was given before the Society and published, with a map showing the geographical results of Major Bright's expedition, in the *Geographical Journal* for August, 1909.

The last paper of this morning's meeting was by Lieut. P. T. Etherton, of the Indian Army, who described his recent remarkable journey from India to the Trans-Siberian railway, and thence to England. Leaving Lansdowne, in the Himalayas in March, 1909, he travelled *viâ* Kashmir, the Gilgit valley, Hunza, Pamirs, Ili Su pass, Yarkand, Tian Shan mountains, Kulja, Great Altai mountains, across the Siberian-Mongolian frontier, to the Trans-Siberian railway. Much of this region was fairly well known, but some parts of the route, such as the pass leading into the Kalan Urgu valley, had not been previously traversed by an explorer.

The Geographical Section met for the last time on the morning of Tuesday, September 6. The first two papers read on this occasion were somewhat similar in character, and consisted of accounts of regional surveys of special districts of England, based upon Ordnance Survey sheets, and drawn up on the lines of Dr. H. R. Mill's well-known description of a part of Sussex, which some years ago formed the subject of discussion at one of the Society's technical meetings. The first of these, by Mr. O. G. S. Crawford, included the Andover district, and the second, by Mr. J. Cossar, was on Midlothian. These were both good examples of the excellent results of the geographical training now to be obtained in the schools of geography attached to the universities of this country. The final papers were also similar in character, one being on the "Underground Waters of the Castleton District," by Mr. H. Brodrick, while in the other Dr. C. A. Hill gave an interesting account of his latest explorations in the Mitchelstown cave, Tipperary, in continuation of the work he described at the Dublin meeting of the Association two years ago.

GEOGRAPHY AND SOME OF ITS PRESENT NEEDS.*

By A. J. HERBERTSON, M.A., Ph.D., Professor of Geography in the University of Oxford, President of the Section.

Geographical Progress in the Last Decade.

At the close of a reign which has practically coincided with the first decade of a new century, it is natural to look back and summarise the progress of geography during the decade. At the beginning of a new reign it is equally natural to consider the future. Our new sovereign is one of the most travelled of men. No monarch knows the World as he knows it; no monarch has ruled over a larger Empire or seen more of his dominions. His advice has been to wake up, to consider and to act. This involves taking existing geographical conditions into account. It will be in consonance with this advice if I pay more attention to the geography of the present and future than to that of the past, and say more about its applications than about its origins. Yet I do so with some reluctance, for the last decade has been one of the most active and interesting in the history of our science.

Among the many geographical results of work in the past decade a few may be mentioned. The measurement of new and the remeasurement of old arcs will give us better data for determining the size and shape of the Earth. Surveys of all kinds, from the simple route sketches of the traveller to the elaborate cadastral surveys of some of the more populous and settled regions have so extended our knowledge of the surface features of the Earth that a map on the scale of 1: 1,000,000 is not merely planned, but actually partly executed. Such surveys and such maps are the indispensable basis of our science.

The progress of oceanography has also been great. The soundings of our own and other Admiralties, of scientific oceanographical expeditions, and those made for the purpose of laying cables, have given us much more detailed knowledge of the irregularities of the ocean floor. An international map of oceanic contours due to the inspiration and munificence of the Prince of Oceanographers and of Monaco has been issued during the decade, and so much new material

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* Presidential Address to the Geographical Section of the British Association for the Advancement of Science, Sheffield, 1910.

has accumulated that it is now being revised. A comparison of the old and new editions of Krümmel's 'Oceanographie' shows us the immense advances in this subject.

Great progress has been made on the geographical side of meteorology and climate. The importance of this knowledge for tropical agriculture and hygiene has led to an increase of meteorological stations all over the hot belt—the results of which will be of value to the geographer. Mr. Bartholomew's 'Atlas of Meteorology' appeared at the beginning, and Sir John Eliot's 'Meteorological Atlas of India' at the end of the decade. Dr. Hann's 'Lehrbuch' and the new edition of his 'Climatology,' Messrs. Hildebrandsson and Teisserenc de Bort's great work, and the recent studies of the Upper Atmosphere are among the landmarks of progress. The record is marred only by the closing of Ben Nevis Observatory at the moment when its work would have been most useful. To appreciate the progress of climatology, it is only necessary to compare the present number and distribution of meteorological stations with those given in Bartholomew's Atlas of 1899. I have not time to recapitulate the innumerable studies of geographical value issued by many meteorological services, observatories and observers—public and private—but I may call attention to the improved weather maps and to the excellent pilot charts of the North Atlantic and of the Indian Ocean published monthly by our Meteorological Office.

Lake studies have also been a feature of this decade, and none are so complete or so valuable as the Scottish Lakes Survey—a work of national importance, undertaken by private enthusiasm and generosity. We have to congratulate Sir John Murray and Mr. Pullar on the completion of a great work.

In Geology I might note that we now possess a map of Europe on a scale of 1 : 1,500,000 prepared by international co-operation and also one of North America on a smaller scale; both invaluable to the geographer. The thanks and congratulations of all geographers are due to Professor Suess on the conclusion of his classical work on the Face of the Earth, the first comprehensive study of the main divisions and characteristics of its skeleton. English readers are indebted to Professor and Miss Sollas for the brilliant English translation which they have prepared.

A new movement, inspired mainly by Professor Flahault in France, Professor Geddes in this country, Professors Engler, Drude, and Schimper in Germany has arisen among botanists, and at last we have some modern botanical geography which is really valuable to the geographer. I wish we could report similar progress in zoological geography, but that, I trust, will come in the next decade.

I pass over the various expensive arbitrations and commissions to settle boundary disputes which have in many cases been due to geographical ignorance, also the important and fascinating problems of the growth of our knowledge of the distribution of economic products, and powers, existing and potential, and the new geographical problems for statesmen due to the political and economic revolutions in Japan and China.

It is quite impossible to deal with the exploration of the decade. Even in the past two years we have had Peary and Shackleton, Stein and Hedin, the Duke of the Abruzzi, and a host of others returning to tell us of unknown or little known parts of the globe. We hope to hear soon from Dr. Charcot the results of the latest investigations in the Antarctic. Further work is being undertaken by Scott and his companions, by Bruce, Amundsen, Filchner, and others in the South or North Polar ice worlds; by Longstaff, Bruce, and others in the mountains of India and Central Asia; by Goodfellow and Rawling in New Guinea; and by many other expeditions.

One word of caution may, perhaps, be permitted. There is a tendency on the part of the public to confuse geographical exploration and sport. The newspaper reporter naturally lays stress on the unusual in any expedition, the accidental rather than the essential, and those of us who have to examine the work of expeditions know how some have been unduly boomed because of some adventurous element, while others have not received adequate popular recognition because all went well. The fact that all went well is in itself a proof of competent organisation. There is no excuse for us in this section if we fall into the journalist's mistake, and we shall certainly be acting against the interests of both our science and our section if we do so.

The Position of Geography in the Association.

It was not my intention in this address to raise the question of what is Geography, but various circumstances make it desirable to say a few words upon it. We are all the victims of the geographical teaching of our youth, and it is easy to understand how those who have retained unchanged the conceptions of geography they gained at school many years ago cavil at the recognition of geography as a branch of science. Moreover, the geography of the schools still colours the conceptions of some geographers, who have nevertheless done much to make school geography scientific and educational. Many definitions of geography are consequently too much limited by the arbitrary but traditional division of school subjects. In schools tradition and practical convenience have, on the whole rightly, determined the scope of the different subjects. Geography in schools is best defined as the study of the Earth as the home of Man. Its limits should not be too closely scrutinized in schools, where it should be used freely as a co-ordinating subject.

The present division into sections of the British Association is also largely a matter of practical convenience, but we are told that the present illogical arrangement of sections distresses some minds. No doubt there are some curious anomalies. The most glaring, perhaps, is that of combining mathematics with physics—as if mathematical methods were not used in any other subject. There is a universal tendency to sub-division and an ever-increasing specialization, but there is also an ever-growing interdependence of different parts of science. The British Association is unquestionably bound to take the latter into account, as well as the former. At present this is chiefly done by joint meetings of sections: a wise course, of which this section has been one of the chief promoters. It is possible that some more systematic grouping of sections might be well advised, but such a reform should be systematic and not piecemeal. It is one which raises the whole question of the classification of knowledge. This is so vast a problem and one on which such divergent opinions are held that I must apologize for venturing to put forward some tentative suggestions.

It might be found desirable to take as primary divisions the Mathematical, Physical, Biological, Anthropological, and Geographical groups. Mathematical applications might be considered in each of the sections which use mathematical notions. In the Physical Group there should be the sub-divisions Physics and Chemistry. Each would devote a certain proportion of time to its applied aspects, or these might be dealt with in sub-sections which would include Engineering and Applied Chemistry. In the Biological Group there would be Botany, Zoology, in both cases including Palæontology and Embryology, and Applied Biology, which would be dealt with in one or other of the ways I have suggested, and would include Agriculture, Fisheries, etc. (Medicine we leave out at present.) In the Anthropological group, in addition to the present

Anthropology and Economics there should be a section on Psychology, which might or might not be attached to Physiology and have the Education section as the practical appendage. In the Geographical group there would be the sub-divisions Geography and Geology, the practical applications of Geography and Geology being considered in joint meetings with other sections, or else in sub-sections—for instance, Geography and Physics for questions of Atmospheric and Oceanic Circulation, Geography and Economics for questions of Transportation, etc.

The Need for Classifications and Notations in Geomorphology, etc.

So much, then, for the classification of Geography with reference to the other sciences. I should like to say a few words about the sub-divisions of geography and the vexed question of terminology. In the scheme of the Universe it is possible to consider the Earth as a unit, with its own constitution and history. It has an individuality of its own, though for the astronomer it is only one example of a particular type of heavenly bodies. As geographers we take it as our unit individual in the same way that an anatomist takes a man. We see that it is made of different parts, and we try to discover what these are, of what they are composed, what their function is, what has been their history. One fundamental division is into land, water, and air. Each has its forms and its movements. The forms are more obvious and persistent in the land. They are least so in the atmosphere, though forms exist—some of which are at times made visible by clouds, and many can be clearly discerned on isobaric charts. The land is the temporarily permanent; the water and atmosphere the persistently mobile, the latter more so than the former. The stable forms of the land help to control the distribution and movements of the waters and to a less extent those of the atmosphere. How great the influence of the distribution of land and water is on the atmosphere may be seen in the monsoon region of Eastern Asia.

The study of the land, the ocean, and the atmosphere has resulted in the growth of special branches of knowledge—geomorphology, oceanography, and climatology. Each is indispensable to the geographer, each forms an essential part of the geographical whole. Much research work is, and will be, carried on in each by geographers, who find their geographical studies hampered for the lack of it. As geographical progress is to a considerable extent conditioned by progress in these subjects, it would be legitimate to examine their needs. Time, however, will admit only a note on one of the barriers to progress in geomorphology—the lack of good classification and notation.

Geomorphology deals with the forms of the land and their shaping. Three things have to be kept clearly in view: (i) The structure, including the composition, of the more permanent substance of the form; (ii) The forces which are modifying it; and (iii) The phase in the cycle of forms characteristic of such structure acted on by such forms. We may say that any form is a function of structure, process, and time. The matter is even more complicated, for we have instances, *e.g.* in antecedent drainage systems, of the conditions of a previous cycle affecting a subsequent one—a kind of heredity of forms which cannot be neglected. The geomorphologist is seeking for a genetic classification of forms, and in the works of Bertrand, Davis, de la Nöe and de Margerie, Penck, Richthofen, Suess, and Supan and their pupils are being accumulated the materials for a more complete and systematic classification of forms. As you all know, the question of terms for the manifold land-forms is a difficult one and apt to engender much more controversy than the analysis of the forms

themselves. I believe that we shall find it advantageous to adopt some notation analogous to that of the chemists. I have not yet had time to work such a notation out in detail, but it might take the form of using different symbols for the three factors noted above—say, letters for different kinds of structure, Arabic figures for processes, and Roman figures for the stage of a cycle the form has reached.

Take a very simple set of structures and indicate each by a letter:

				Undisturbed.	Faulted.
Structure	homogeneous		...	A	A′
	layered	horizontal	...	B	B′
		tilted	...	C	C′
		folded	...	D	D′
	mixed			E	E′

If pervious or impervious, a *p* or an *i* could be added—*e.g.* a tilted limestone with faults would be C′*p*.

Next indicate the commoner erosion processes by Arabic numerals:

Process ...	moving water	1
	ice	2
	wind	3
	sea	4

One process may have followed another, *e.g.* where a long period of ice erosion has been followed by water erosion we might write 2·1 where these alternate annually, say 21. The phase of the cycle might be denoted by Roman figures. A scale of V might be adopted and I, III, and V used for youthful, middle-aged and old-aged, as they have been called; or early, middle, and late phases, as I prefer to term them. II and IV would denote intermediate phases. A scarped limestone ridge in a relatively mature phase like the Cotswolds would be, if we put the process first—1 C′ III.: A highland like the Southern Uplands would be denoted by the formula 1.2.1 E′ III. This is the roughest suggestion, but it shows how we could label our cases of notes, and pigeon-hole our types of forms—and prevent for the present undue quarrelling over terms.* No doubt there would be many discussions, for example, about the exact phase of the cycle, whether ice in addition to water has been an agent in shaping this or that form, and so on. But, after all, these discussions would be more profitable than quarrels as to which descriptive term, or place-name, or local usage should be adopted to distinguish it. The use of such notations in geographical problems is not unknown. They were employed by Köppen in his classification of climate; and now, in the case of climatology, there is coming to be a general consensus of opinion as to what are the chief natural divisions, and the use of figures and letters to indicate them has been followed by several other authors. This should also be attempted for oceanography. If any international agreement of symbols and colours could be come to for such things it would be a great gain, and I hope to bring this matter before the next International Geographical Congress.

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* What I wish to make clear is that it is not necessary to invent a new term for every new variety of land-form as soon as it is recognized. It will suffice at first to be able to label it. The notation will also stimulate the search for and the recognition of new varieties.

The Need for Selecting Natural Geographical Units.

We have still to come to Geography proper, which considers land, water, and air not merely separately, but as associated together. What are the units smaller than the whole Earth with which our science has to deal?

When we fix our attention on parts of the Earth, and ask what is a natural unit, we are hampered by preconceptions. We recognize species, or genera, families, or races as units—but they are abstract rather than concrete units. The reason for considering them as units is that they represent a historical continuity. They have not an actual physical continuity such as the component parts of an individual have. Concrete physical continuity in the present is what differentiates the geographical unit. Speaking for myself, I should say that every visible concrete natural unit on the Earth's surface consisting of more than one organic individual is a geographical unit. It is a common difficulty not to be able to see the wood for the trees; it is still more difficult to recognize that the wood consists of more than trees, that it is a complex of trees and other vegetation, fixed to a definite part of the solid earth and bathed in air. We may speak of a town or state as composed of people, but a complete conception of either must include the special connections which unite its parts. A town is not merely an association of individuals, nor is it simply a piece of land covered with streets and buildings; it is a combination of both.

It is true that in determining the greater geographical units, man need not be taken into account. We are too much influenced by the mobility of man, by his power to pass from one region to another, and we are apt to forget that his influence on his environment is negligible except when we are dealing with relatively small units. The geographer will not neglect man; he will merely be careful to prevent himself from being unduly influenced by the human factor in selecting his major units.

Some geographers and many geologists have suggested that land forms alone need be taken into account in determining these larger geographical units. Every different recognizable land form is undoubtedly a geographical unit. A vast lowland such as that which lies to the east of the Rocky mountains, is undoubtedly a geographical unit of great importance, but its geographical subdivisions are not necessarily orographical. The shores of the Gulf of Mexico could not be considered as geographically similar to those of the Arctic ocean, even if they were morphologically homologous. The lowlands of the polar regions are very different from those at or near the tropics. The rhythm of their life is different, and this difference is revealed in the differences of vegetation. I wish to lay great stress on the significance of vegetation to the geographer for the purpose of regional classification. I do not wish to employ a biological terminology nor to raise false analogies between the individual organism and the larger units of which it is a part, but I think we should do well to consider what may be called the life or movement going on in our units as well as their form. We must consider the seasonal changes of its atmospheric and of its water movements, as well as the parts of the Earth's crust which they move over and even slightly modify. For this purpose a study of climatic regions is as necessary as a study of morphological regions, and the best guides to the climatic regions are the vegetation ones.

By vegetation I mean not the flora, the historically related elements, but the vegetable coating, the space-related elements. Vegetation in this sense is a geographical phenomenon of fundamental importance. It indicates quality—quality of atmosphere and quality of soil. It is a visible synthesis of the climatic

and edaphic elements. Hence the vast lowlands of relatively uniform land features are properly divided into regions according to vegetation—tundra, pine forest, deciduous forest, warm evergreen forest, steppe, and scrub. Such differences of vegetation are full of significance even in mountainous areas.

The search after geographical unity—after general features common to recognizable divisions of the Earth's surface, the analysis of these, their classification into types, the comparisons between different examples of the types—seems to me among the first duties of a geographer. Two sets of studies and maps are essential—topographical and vegetational—the first dealing with the superficial topography and its surface irregularities, the latter relating to the quality of climate and soil. Much has been said in recent years—more particularly from this Presidential chair—on the need for reliable topographical maps. Without such maps no others can be made. But when they are being made it would be very easy to have a general vegetational map compiled. Such maps are even more fundamental than geological maps, and they can be constructed more rapidly and cheaply. Every settled country, and more particularly every partially settled country, will find them invaluable if there is to be any intelligent and systematic utilization of the products of the country. Possessing both sets of maps, the geographer can proceed with his task.

This task I am assuming is to study environments, to examine the forms and qualities of the Earth's surface, and to recognize, define, and classify the different kinds of natural units into which it can be divided. For these we have not as yet even names. It may seem absurd that there should be this want of terms in a subject which is associated in the minds of most people with a superfluity of names. I have elsewhere suggested the use of the terms major natural region, natural region, district, and locality to represent different grades of geographical units, and have also attempted to map the seventy or eighty major natural regions into which the Earth's surface is divided, and to classify them into about twenty types. These tentative divisions will necessarily become more accurate as research proceeds, and the minor natural regions into which each major natural region should be divided will be definitely recognized, described, and classified. Before this can be done, however, the study of geomorphology and of plant formations must be carried far beyond the present limits.

The value of systematic and exhaustive studies of environment, such as those I suggest, can hardly be exaggerated. Without them all attempts to estimate the significance of the environment must be superficial guesswork. No doubt it is possible to exaggerate the importance of the environmental factor; but it is equally possible to undervalue it. The truly scientific plan is to analyze it and to evaluate it. Problems of the history of human development, as well as those of the future of human settlements, cannot be solved without this. For the biologist, the historian, the economist, the statesman, this work should be carried out as soon and as thoroughly as is possible in the present state of our knowledge.

A beginning of systematic geographical studies has also been made at the opposite end of the scale, in local geographical monographs. Dr. H. R. Mill, one of the pioneers of geography in this country and one of my most distinguished predecessors in this chair, has given us in his study of south-west Sussex an admirable example of the geographical monograph proper, which takes into account the whole of the geographical factors involved. He has employed quantitative methods as far as these could be applied, and in doing so has made a great step in advance. Quantitative determinations are at least as

essential in geographical research as the consideration of the time factor. At Oxford we are continuing Dr. Mill's work. We require our diploma students to select some district shown on a sheet of this map for detailed study by means of map measurements, an examination of statistics and literature which throw light on the geographical conditions, and, above all, by field work in the selected district. Every year we are accumulating more of these district monographs, which ought, in their turn, to be used for compiling regional monographs dealing with the larger natural areas. In recent years excellent examples of such regional monographs have come from France and from Germany.

The geomorphologist and the sociologist have also busied themselves with particular aspects of selected localities. Professor W. M. Davis, of Harvard, has published geomorphological monographs which are invaluable as models of what such work should be. In a number of cases he has passed beyond mere morphology and has called attention to the organic responses associated with each land form. Some of the monographs published under the supervision of the late Professor Ratzel, of Leipzig, bring out very clearly the relation between organic and inorganic distributions, and some of the monographs of the Le Play school incidentally do the same.

The Double Character of Geographical Research.

To carry on geographical research, whether on the larger or the smaller units, there is at present a double need, in the first place, of collecting new information, and in the second place, of working up the material which is continually being accumulated.

The Need for the Systematic Collection of Data.

The first task—that of collecting new information—is no small one. In many cases it must be undertaken on a scale that can be financed only by Governments. The Ordnance and Geological Surveys of our own and other countries are examples of government departments carrying on this work. We need more of them. The Presidents of the Botanical and Anthropological Sections, I understand, are calling the attention of the Association to the urgent necessity for complete Botanical and Anthropological Surveys of the kingdom. All geographers will warmly support their appeal, for the material which would be collected through such surveys is essential to our geographical investigations.

Another urgent need is a Hydrographical Department, which would co-operate with Dr. Mill's rainfall organization. It would be one of the tasks of this department to extend and co-ordinate the observations on river and lake discharge, which are so important from an economic or health point of view that various public bodies have had to make such investigations for the drainage areas which they control. Such research work as that done by Dr. Strahan for the Exe and Medway would be of the greatest value to such a department, which ought to prepare a map showing all existing water rights, public and private. We shall see how serious the absence of such a department is if we consider how our water-supply is limited, and how much of it is not used to the best advantage. We must know its average quantity and the extreme variations of supply. We must also know what water is already assigned to the uses of persons and corporations, and what water is still available. We shall have to differentiate between water for the personal use of man and animals, and water for industrial purposes. The actualities and the potentialities can be ascertained, and should be recorded and mapped.

The Need for the Application of Geographical Methods to already Collected Data.

In the second direction of research—that of treating from the geographical standpoint the data accumulated, whether by government departments or by private initiative—work has as yet hardly been begun. The topographical work of the Ordnance Survey is the basis of all geographical work in our country. The Survey has issued many excellent maps, none more so than the recently published half-inch contoured and hill-shaded maps with colours in layers. Its maps are not all above criticism; for instance, few can be obtained for the whole kingdom having precisely the same symbols. It has not undertaken some of the work that should have been done by a national cartographic service—for instance, the lake survey. Nor has it yet done what the Geological Survey has done—published descriptive accounts of the facts represented on each sheet of the map. From every point of view these are great defects; but in making these criticisms we must not forget (i) that the Treasury is not always willing to find the necessary money, and (ii) that the Ordnance Survey was primarily made for military purposes, and that the latest map it has issued has been prepared for military reasons. It has been carried out by men who were soldiers first and topographers after, and did not necessarily possess geographical interests.

The ideal geographical map, with its accompanying geographical memoir, can be produced only by those who have had a geographical training. Dr. Mill, in the monograph already referred to, has shown us how to prepare systematized descriptions of the one-inch map sheets issued by the Ordnance Survey. The preparation of such monographs would seem to fall within the province of the Ordnance Survey. If this is impossible, the American plan might be adopted. There the Geological Survey, which is also a topographical one, is glad to obtain the services of professors and lecturers who are willing to undertake work in the field during vacations. It should not be difficult to arrange similar co-operation between the Universities and the Ordnance Survey in this country. At present the Schools of Geography at Oxford and at the London School of Economics are the only University departments which have paid attention to the preparation of such monographs, but other Universities will probably fall into line. Both the Universities and the Ordnance Survey would gain by such co-operation. The chief obstacle is the expense of publication. This might reasonably be made a charge on the Ordnance Survey, on condition that each monograph published were approved by a small committee on which both the Universities and the Ordnance Survey were represented.

The Geological Survey has in recent years issued better and cheaper one-inch maps, and more attention has been given to morphological conditions in the accompanying monographs; but it is necessary to protest against the very high prices which are now being asked for the older hand-coloured maps. The new quarter-inch map is a great improvement on the old one, but we want "drift" as well as "solid" editions of all the sheets. The geographer wants even more than these a map showing the quality of the solid rock, and not merely its age. He has long been asking for a map which would indicate the distribution of clay, limestone, sandstone, etc., and when it is prepared on the quarter-inch, or better on the half-inch, scale, the study of geomorphology and of geography will receive a very great stimulus and assistance.

The information which many other government departments are accumulating would also become much more valuable if it were discussed geographically. Much excellent geographical work is done by the Admiralty and the War Office. The Meteorological Office collects statistics of the weather conditions from a limited number of stations; but its work is supplemented by private societies

which are not well enough off to discuss the observations they publish with the detail which these observations deserve. The Board of Agriculture and Fisheries has detailed statistical information as to crops and live stock for the geographer to work up. From the Board of Trade he would obtain industrial and commercial data, and from the Local Government Board vital and other demographic statistics. At present most of the information of these departments is only published in statistical tables.

Statistics are all very well, but they are usually published in a tabular form, which is the least intelligible of all. Statistics should be mapped and not merely be set out in columns of figures. Many dull Blue Books would be more interesting and more widely used if their facts were properly mapped. I say *properly* mapped because most examples of so-called statistical maps are merely crude diagrams and are often actually misleading. It requires a knowledge of geography in addition to an understanding of statistical methods to prepare intelligible statistical maps. If Mr. Bosse's maps of the population of England and Wales in Bartholomew's Survey Atlas are compared with the ordinary ones, the difference between a geographical map and a cartographic diagram will be easily appreciated.

The coming census, and to a certain extent the census of production, and probably the new land valuation, will give more valuable raw material for geographical treatment. If these are published merely in tabular form they will not be studied by any but a few experts. Give a geographer with a proper staff the task of mapping them in a truly geographical way and they will be eagerly examined even by the man in the street, who cannot fail to learn from them. The representation of the true state of the country in a clear, graphic and intelligible form is a patriotic piece of work which the Government should undertake. It would add relatively little to the cost of the census and it would infinitely increase its value.

The Need of recognizing the Geographical Factor in Imperial Problems.

With such quantitative information geographically treated and with a fuller analysis of the major natural regions, it ought to be possible to go a step further and to attempt to map the economic value of different regions at the present day. Such maps would necessarily be only approximations at first. Out of them might grow other maps prophetic of economic possibilities. Prophecy in the scientific sense is an important outcome of geographical as well as of other scientific research. The test of geographical laws as of others is the pragmatic one. Prophecy is commonly but unduly derided. Mendelyeff's period law involved prophecies which have been splendidly verified. We no longer sneer at the weather prophet. Efficient action is based on knowledge of cause and consequence, and proves that a true forecast of the various factors has been made. Is it too much to look forward to the time when the geographical prospector, the geographer who can estimate potential geographical values, will be as common as and more reliable than the mining prospector?

The day will undoubtedly come when every Government will have its Geographical-Statistical Department dealing with its own and other countries—an Information Bureau for the administration corresponding to the Department of Special Inquiries at the Board of Education. At present there is no geographical staff to deal geographically with economic matters or with administrative matters. Yet the recognition of and proper estimation of the geographical factor is going to be more and more important as the uttermost ends of the Earth are bound together by visible steel lines and steel vessels or invisible impulses which require

no artificial path or vessel as their vehicle. The development of geographical research along these lines in our own country could give us an Intelligence Department of the kind, which is much needed. If this were also done by other States within the Empire, an Imperial Intelligence Department would gradually develop. Thinking in continents, to borrow an apt phrase of Mr. Mackinder's, might then become part of the necessary equipment of a statesman instead of merely an after-dinner aspiration. The country which first gives this training to its statesmen will have an immeasurable advantage in the struggle for existence.

The Need for the Adequate Endowment of Geography at the Universities.

Our universities will naturally be the places where the men fit to constitute such an Intelligence Department will be trained. It is encouraging, therefore, to see that they are taking up a new attitude towards geography, and that the Civil Service Commissioners, by making it a subject for the highest Civil Service examinations, are doing much to strengthen the hands of the universities. When the British Association last met in Sheffield geography was the most despised of school subjects, and it was quite unknown in the universities. It owed its first recognition as a subject of university status to the stimulus and generous financial support of the Royal Geographical Society and the brilliant teaching of Mr. Mackinder at Oxford. Ten years ago Schools of Geography were struggling into existence at Oxford and Cambridge, under the auspices of the Royal Geographical Society. A single decade has seen the example of Oxford and Cambridge followed by nearly every university in Great Britain, the University of Sheffield among them. In Dr. Rudmose Brown it has secured a scientifically trained traveller and explorer of exceptionally wide experience, who will doubtless build up a Department of Geography worthy of this great industrial capital. The difficulty, however, in all universities is to find the funds necessary for the endowment, equipment, and working expenses of a Geographical Department of the first rank. Such a department requires expensive instruments and apparatus, and, since the geographer has to take the whole World as his subject, it must spend largely on collecting, storing, and utilizing raw material of the kind I have spoken of. Moreover, a professor of geography should have seen much of the World before he is appointed, and it ought to be an important part of his professional duties to travel frequently and far. I have never been able to settle to my own satisfaction the maximum income which a Department of Geography might usefully spend, but I have had considerable experience of working a department the income of which was not very far above the minimum. Until now the Oxford School of Geography has been obliged to content itself with three rooms, and to make these suffice not merely for lecture-rooms and laboratories, but also for housing its large and valuable collection of maps and other materials. This collection is far beyond anything which any other university in this country possesses, but it shrinks into insignificance beside that of a rich and adequately supported Geographical Department like that of the University of Berlin. This fortunate department has an income of about £6000 a year, and an institute built specially for its requirements at a cost of over £150,000, excluding the site. In Oxford we are most grateful for the generosity of Mr. Bailey of Johannesburg, which will enable the School of Geography to add to its accommodation by renting for five years a private house, in which there will temporarily be room for our students and for our collections, especially those relating to the geography of the empire. But even then we can never hope to do what we might if we had a building specially designed for geographical

teaching and research. Again, Lord Brassey and Mr. Douglas Freshfield, a former President of this Section, have each generously offered £500 towards the endowment of a professorship if other support is forthcoming. All this is matter for congratulation, but I need hardly point out that a professor with only a precarious working income for his department is a person in a far from enviable position. There is at present no permanent working income guaranteed to any Geographical Department in the country, and so long as this is the case the work of all these departments will be hampered and the training of a succession of competent men retarded. I do not think that I can conclude this brief address better than by appealing to those princes of industry who have made this great city of Sheffield what it is, to provide for the Geographical Department of their University on a scale which shall make it at once a model and a stimulus to every other university in the country and to all benefactors of universities.

REVIEWS.

EUROPE.

The Scottish Lochs.

'Bathymetrical Survey of the Scottish Fresh-water Lochs,' conducted under the direction of Sir John Murray, K.C.B., F.R.S., D.SC., etc., and Laurence Pullar, F.R.S.E., F.R.G.S., during the years 1897 to 1909. Report on the Scientific Results. 6 volumes. Edinburgh: Challenger Office. 1910. £5 5*s*.

The splendid and valuable work done by the Scottish Lake Survey under the supervision of Sir John Murray, the late Mr. Frederick Pattison Pullar, and Mr. Laurence Pullar is well known through the eighteen separate papers published in this *Journal* between April, 1900, and January, 1908, and in an extra publication of the Society.

The publication under notice consists of six volumes, two of text and four of maps. This review will deal especially with vol. 1, which consists for the most part of new matter, whilst vol. 2 contains the special descriptions of the lakes already published.

In vol. 1 we find, after statistical tables of the Scottish Fresh-water Lochs and the introduction by Sir John Murray, an article on *Seiches and Other Oscillations of Lake Surfaces observed by the Scottish Lake Survey*, by Prof. G. Chrystal. This article is one of the best and most up-to-date *résumés* of the seiches problem. Physiographers will find therein the history of this interesting question, the description of the apparatus used in the survey of Lochs Earn, Tay, and Lubnaig, and the various causes of the denivellation registered by a limnograph. Amongst these denivellations the most important are the stationary oscillations of the whole lake, or "seiches." Prof. Chrystal gives also the results of his valuable studies on the mathematical theory of seiches. With Mr. Maclagan-Wedderburn he calculated the periods and nodes of Lochs Earn and Treig from the bathymetric data of the survey, and the pages in which he compares the positions given by calculation with those given by direct observation are very interesting, and show the accuracy of the theory. Many pages are also devoted to the problem of the origin of seiches.

Temperature of Scottish Lakes, by E. M. Wedderburn. After the history of temperature observations in Scottish lakes, Mr. Wedderburn, who has taken a large part in the thermic studies during the survey, gives the results arrived at.

Most of the lakes of Scotland, from a thermic point of view, belong to Forel's tropical class. In spring the water of such lakes is all of uniform temperature. In summer the lake gains heat and becomes stratified. In the third phase the "discontinuity layer" (or Sprungschicht) has made its appearance, and there is at the surface a layer of water of nearly uniform temperature, resting on a layer of rapidly varying temperature—the discontinuity layer. Below we find the abysmal waters of the lake, also of uniform temperature. As the season progresses the discontinuity layer, by transference of heat from the upper to the lower layer by conduction, sinks deeper until finally the loch is again of uniform temperature from top to bottom.

One of the most interesting facts brought to light by the Scottish Lake Survey is the "temperature seiche," a kind of wave produced in the lower of two liquids of different densities. This is the case in the lakes when the discontinuity is marked between the upper warm water and the lower cold water. Such a seiche has a very long period. Prof. Thoulet, in 1890, discovered this principle in the lake of Longemer, in the Vosges, and thirteen years later E. R. Watson, ignorant of Thoulet's observations, rediscovered the temperature oscillations in Loch Ness.

The Chemical Composition of Lake Waters, by W. A. Caspari. This rather short article is written from a general point of view. But the author shows that the waters of the mainland lochs are exceedingly pure. Both for Loch Ness and Loch Katrine 0·029 part per thousand of total solids (organic included) are reported, the figure for the Lake of Geneva being 0·169. Peaty waters are very common.

The Deposits of the Scottish Fresh-water Lochs, by W. A. Caspari. The lake deposits have been classified by the author as follows: (1) Sand or grit; (2) clay; (3) brown mud, the latter being the loch deposit *par excellence*. Three other types occur sporadically, and are by way of being rarities, viz. (4) diatom ooze; (5) ochreous mud; (6) calcareous deposits.

An Epitome of a Comparative Study of the Dominant Phanerogamic and Higher Cryptogamic Flora of Aquatic Habit in Seven Lake Areas of Scotland, by George West. The systematic list of the plants given by Mr. George West is of great value, not only to limnologists, but also to botanists. The nine plates from photos of the author show well the different types of Scottish lakes.

Biology of the Scottish Lochs, by James Murray. The biological researches of the survey were concerned solely with the Invertebrata. These observations were carried on by Mr. James Murray until he left to take part as biologist in Lieut. Shackleton's Antarctic expedition. In the course of the work twenty-nine species previously unknown have been found. The whole of the Tardigrada (thirty species) and twenty-five species of Rotifera *are additions to the British fauna*. Three species of Crustacea were found for the first time in Great Britain. Many of the Sarcodina, some Desmids, and Mites are also additions to the British lists. The census of the species given in Mr. James Murray's paper will be of great interest to biologists as well as to limnologists.

Some Distinctive Characters in the Fresh-water Plankton from Various Islands off the North and West Coasts of Scotland, by John Hewitt. This paper, illustrated by six plates, will be read with great interest by specialists. A *résumé* of such an article does not fall within the scope of this review.

On the Nature and Origin of Fresh-water Organisms, by W. A. Cunnington. Fresh-water organisms are the modified descendants of marine ancestors. If certain types only are to be found in all the fresh waters of the globe, it is because they alone have been able to adapt themselves to the peculiar conditions. The author thinks that passive transportation has been the most effectual agent in securing the spread of fresh-water organisms.

Summary of our Knowledge regarding Various Limnological Problems, by C. Wesenberg-Lund. After a very interesting "contribution to the general geography of the lakes," Dr. Wesenberg-Lund gives a brief review of the investigations of recent years on the variation of plankton organisms. Then, at Sir John Murray's request, the author exposes his own views on the main problems of future limnological investigations. Amongst these the author states that a thorough exploration of one of the great tropical lakes is one of the most desirable objects for the advancement of limnology.

The Scottish Lakes in Relation to the Geological Features of the Country, by B. N. Peach and J. Horne. This article could not have been written by greater authorities on the subject. These well-known geologists first describe, as no one else could have done, the geological features of Scotland, accompanied by a geological and an orographical and bathymetrical map of Scotland. The chapter devoted to the glaciation of Scotland is illustrated by a map showing direction of ice-flow and probable ice front in North-Western Europe during maximum glaciation. The authors show that by far the largest number of Scottish lakes belong to the following classes: lakes resulting from the irregular distribution of the drift, and lakes occupying rock basins. In an appendix the authors give geological notes on Scottish lochs sounded by the Lake Survey. The maps and notes on surface geology of some of the areas in which lakes are situated give great value to vol. 2 of these reports.

The Characteristics of Lakes in General, and their Distribution over the Surface of the Globe, by Sir John Murray. In this article Sir John Murray reviews the distribution and peculiarities of lakes all over the world. This great limnologist and oceanographer distinguishes, from a limnological point of view, two divisions of the land surfaces, viz. *the region of inland drainage areas*, and *the region of areas draining to the ocean*. In the former region evaporation exceeds precipitation, whilst it is the reverse in the latter region, the waters from which flow directly into the ocean. From the 250 lakes briefly described by the author, 60 are situated in inland drainage areas, and the remaining 190 lakes are situated in the areas which drain directly to the ocean. The author comes to the conclusion that the most abundant development of lakes at the present time is found in regions which have, in recent geological times, been covered by an ice-sheet. Sir John Murray gives, at the end of this capital paper, tables of the principal lakes of the world arranged according to—I. Superficial area, II. Volume, III. Maximum depth, IV. Altitude.

The value of the volume is greatly enhanced by the *Bibliography of Limnological Literature*, compiled in the Challenger Office by the general secretary of the Lake Survey, Mr. James Chumley. These hundred pages represent a large amount of work that will be useful, if not necessary, to all those interested in limnological researches from every point of view. Mr. Chumley is to be complimented upon this very valuable bibliography.

The Reports of the Scottish Lake Survey will take their place beside Prof. Forel's well-known volumes on the "Leman," to enlarge considerably the base of limnology.

The reviewer had the honour to present, at the last International Geographical Congress at Geneva, a summary of the results arrived at by the Scottish Lake Survey. On Prof. Forel's proposition, the members of the Congress present at the "Septième Séance Générale" voted thanks and compliments to Sir John Murray and Mr. Laurence Pullar for their splendid record, which shows what can be done by private enterprise.

These Reports are dedicated *to the Memory of Fred. P. Pullar*, who was

drowned while attempting to save the lives of others in one of the Scottish lochs, and they form a worthy memorial of one of the originators of the Scottish Lake Survey. LÉON W. COLLET.

'The Valley of Aosta.' By F. Ferrero. (New York and London: Putman. 1910. Pp. xvi., 336. *Maps and Illustr.* 7*s.* 6*d. net.*) This volume presents a somewhat rare combination, the author having applied genuine geographical study and historical and archæological research in the district dealt with. His *métier* is apparently the two last of these; he does not appear to have any great command of the subject of physical geography, and the maps are elementary. But the whole book is eminently readable, and shows, at any rate, a most minute knowledge of the ground.

'Quiet Days in Spain.' By C. Bogue Luffmann. (London: Murray. 1910. Pp. xvi., 318. 8*s. net.*) The author has written of Spain before, and knows it well; but to judge from this work his interests lie entirely with the people, not with their country. And, truth to tell, the personal reminiscences which fill the bulk of the volume are not illuminating.

'Alpine Profile Road Book.' By R. H. U. Ellis. (London: Cyclists' Touring Club. 1910. Pp. 148. *Diagrams.* 3*s.* 6*d. net.*) This excellent little volume covers all the main routes between Geneva and Cortina and between Lucerne and Innsbruck and the Italian frontier. The profile diagrams are particularly clear, with scales in feet and inches, and there are careful directions and descriptions of the various passes and routes, which, it may be added, are by no means confined to cycling roads.

ASIA.

'A Systematic Geography of Asia.' By G. W. Webb. (London: Methuen. 1910. Pp. viii., 100. *Diagrams.* 1*s.*) This volume, like many of the same type, seems to attempt too much. It is not possible to give a topographical, economic, and historical survey of every component political unit of Asia in the compass of a hundred pages, if it is to be of much educational value. We submit that from general works of this sort the history, at least—piecemeal notes, covering perhaps thirty centuries in a page, and not particularly connected with the geographical treatment—be dropped. Apart from this objection to principles, the present volume is simply written and easy to read, and as systematic as it claims to be.

'A Short History of Burma.' By S. W. Cocks. (London: Macmillan. 1910. Pp. x., 229. *Map and Illustr.* 2*s. net.*) The author's manner of telling the story of Burma, with all its strange interest and incident, is as unemotional as an official document. But the book is admirably lucid and well proportioned, and should prove a useful text-book wherever this chapter of history is taught. It has a map distinguished by a number of place-rings to which no names are attached.

'The Russian Road to China.' By Lindon Bates. (London: Constable. 1910. Pp. ix., 391. *Map and Illustrations.* 10*s.* 6*d.*) The Trans-Siberian railway is used as a chain to link together a series of notes on divers subjects—description of towns and territories, history, the estimate of Roman development in Asia, and what not. The result is readable and informative, and the illustrations are good.

'Sport and Travel in the Far East.' By J. C. Grew. (London: Constable. 1910. Pp. xiv., 264. *Illustrations.* 10*s.* 6*d.*) This volume ranges very far east—even to New Zealand, though it is mainly concerned with shooting in India (Kashmir, Baltistan), while there is an interesting account of a tiger hunt in the Amoy district of China, and of an abortive journey in the Malay peninsula. In the intervals of sport there is ample description of scenes and experiences of travel, very pleasantly written, and the author's photographs are excellent.

'Les Indes Néerlandaises.' By A. Cabaton. (Paris: Guilmoto. 1910. Pp. viii., 380. *Map.* 8 *fr.*) Detailed geographical treatises on Netherlands India are not numerous outside the Dutch language, and this one should be welcome. The physical geography and kindred subjects, the native and European population, the system of government and economic conditions are thoroughly dealt with, first for Java, then for the remaining territories individually. The whole seems thorough and strictly systematic, and full use has been made of the most recent official sources of information.

AFRICA.

German South-West Africa.

'Im deutschen Diamantenlande. Deutsch-Südwest Afrika von der Errichtung der deutschen Herrschaft bis zur Gegenwart (1884–1910).' By Major Kurd Schwabe. Berlin: Ernest Siegfried Mittler und Sohn. [1909.] 10*m.*

This fancifully named volume is mainly (as the sub-title indicates) a history of the German South-West Africa protectorate, and is based on the author's experience in that country since 1893. The first chapter summarizes (in sixteen pages) events previous to that date, while fully a third of the volume is taken up with an account of the Hottentot and Herero war of 1903–8. The story is graphically told. That war has led, not only to a better appreciation of the natives by the Germans, but to a more lively interest in the land which has cost them so much blood and treasure. Major Schwabe also devotes attention to the economic resources of the country, both agricultural and mineral, including a page or two on the recent discoveries of diamonds in the Lüderitz bay district.

The various railways are described, and a sketch-map shows the mining areas served by them as well as those still without transport facilities. Some of the photographs given clearly illustrate the new economic conditions. A brief account of the peoples of the protectorate and of mission work is likewise given. A chapter is devoted to the little-known northern region inhabited mainly by the Ovambo. Besides the sketch-map mentioned, there is a general map on the scale of 1:5,000,000. The book, owing to the leaded paper used, is very heavy to handle.

F. R. C.

The Akikuyu.

'With a Prehistoric People: the Akikuyu of British East Africa.' By W. Scoresby Routledge and Katherine Routledge. 136 *Illustrations and Map.* Pp. xxxii., 392. London: Edward Arnold: 1910. 21*s. net.*

By "prehistoric" is here meant, not the remote epoch corresponding to the Stone Ages of Europe and America, but merely the period which in most of East Africa precedes all written records. In the present instance, the time actually in question runs from the middle of 1902 to the beginning of 1908. Save for a short visit to England, whence he returned with Mrs. Routledge in 1904, the whole of this period was spent by Mr. Routledge in intimate association with the natives of Kikuyuland. Both he and his wife devoted themselves to the closest study of the people, and the varied and trustworthy information thus collected at first hand regarding their political and social institutions, traditions, primitive beliefs, daily life, folklore and other particulars, are embodied in this valuable and profusely illustrated volume.

There are four distinct sections, of which the first, dealing mainly with "the arts and crafts," is to be credited to Mr. Routledge, and the second—"the women and social and political life"—to Mrs. Routledge, while the third and fourth result from a sort of dual authorship. But all alike are equally accurate, and collectively form what will be welcomed by anthropologists as one of the choicest

contributions to the study of primitive peoples that have appeared in recent times. Here not only are new facts brought together, but some errors and misconceptions of long standing are corrected. Thus the contradictory evidence regarding the son's inheritance of his father's wives either as guardian or actual possessor is satisfactorily explained. "The solution proved to be that the son may not take in marriage either the first, second, or third wife of his late father; to these he stands in the position of guardian: the fourth or any other he may properly add to his own household."

A most informing account is given of the "medicine man," in whom are combined the various functions of "magician, medical practitioner, prophet, and in some respects priest." In him are, in fact, concentrated all the progressive phases in the development of early beliefs. But although as a doctor he is essentially a specialist, it is explained that his province is not the *cure* of disease, but the possession of magic charms by which the disease is averted. Some of these may be purchased from colleagues for a consideration, while others are heirlooms held in common by the clan and available against lions and other foes. Mrs. Routledge, who deals with this matter, thinks, from her experience, that these soothsayers act in good part, "fully believing in the efficacy of their rites and medicines." One of these objects, not met elsewhere amongst the pagan negroes, is a clay image, which, being worshipped, may be called a real idol. There are both male and female effigies, and when they are held up for adoration, they create the wildest excitement amongst the "congregation." It was stated that whoever saw them must needs dance, although "there was nothing sacred in the image itself, but that no one would think of treating it with disrespect." It looks like a sort of half-measure between fetishism and true idolatry.

On the arrested progress of the adult negro we read that "it is a well-known fact that the native races show in childhood intelligence and adaptability which may be said to equal that of their white compeers, but that with earliest manhood and womanhood development seems to cease, or even retrogression to set in." No clear reason is given for this physiological phenomenon, but an explanation will be found in my 'Ethnology,' p. 44, where it is referred to the premature closing of the cranial sutures, by which the normal expansion of the brain, and consequently of the mental faculties, is arrested.

Reference is made to the strange mystery which in so many places is connected with the production of iron and with the workers in that metal. In some districts, as in parts of Sudan, the smith is regarded as a sort of foul fiend or superman whom it is equally dangerous to scorn or to wheedle. In Kikuyuland they scarcely know what to make of him, and even the places where the metal comes from are kept a profound secret. The ironworkers are taboo for some of the clans, although there is nothing of the nature of a trade guild amongst them, nor is the smelting of iron associated with any ceremonial rites. "The curse of a smith is, however, considered to be particularly biting and adhesive, and is expensive for him who has fallen beneath its ban."

The book is well equipped, with fine paper, large type, a profusion of illustrations, a good map of the district, several useful appendices, a glossary of Ge-Kikuyu words, a comprehensive bibliography, and a fairly copious index.

A. H. KEANE.

EAST CENTRAL AFRICA.

'Fighting the Slave Hunters in Central Africa.' By Alfred J. Swann. *With 45 Illustrations and Map.* London: Seeley & Co., Ltd. 16*s. net.*

Mr. Alfred Swann is one of the diminishing band of the pioneers of civilization in East Central Africa—one of those pioneers, that is, who made no startling

geographical discoveries, but who by prolonged residence in the country effected so marvellous a transformation in the conditions of life that the traveller of to-day can hardly realize the aspect which it presented only thirty years ago. Mr. Swann's book covers the period 1882–1909, and his pages are mostly (and rightly) devoted to the earlier years. In 1882, at the very beginning of the partition era, he accompanied Captain Hore on the memorable journey from Zanzibar to Tanganyika to carry the first steel boat to that lake and to open up work in that region for the London Missionary Society. At Ujiji he met Tippu Tib and his partner Rumaliza, and other great Arab slave-dealers—who appear to have recognized in the arrival of the London Missionary Society party the handwriting on the wall. Tippu and Rumaliza were engaged in a hateful trade, but they were men and gentlemen, and to their intervention on at least one occasion Mr. Swann and his party owed their lives. Mr. Swann's account of these Arab slavers of Tanganyika throws a vivid and valuable light on an obscure yet critical chapter of African history. He is provokingly sparing of dates, and some things he might have told us are omitted, but these pages help to make clear and to correct what has been written by Sir H. M. Stanley, Dr. Brode, and others about Tippu Tib and the Zanzibar Arabs. This part of the book we have found peculiarly fascinating, but every one of Mr. Swann's pages is interesting. After several years' service on Tanganyika he went south to Nyasa, and had a distinguished share in shaping the fortunes of that part of British Central Africa, while at one period, as agent for Consul (Sir) Harry Johnston, he went north of Tanganyika and concluded treaties which, had they been upheld by the British Government, would have made the Cape to Cairo connection an "all red" route.

It is impossible to review this book in detail, but with comparatively little alteration it might take rank in a series of historical geographies. The author's power of graphic portraiture, if not so (apparently) artless, reminds us of that of J. H. Speke, and it enables him to bring to life again the Africa of the "eighties"; the lives and loves of the natives, their humanity, their capacity for higher things, are revealed with a sure touch. Nor is there any lack of exciting adventures, thrillingly told. The illustrations are excellent. F. R. C.

British Africa.

'Britain across the Seas—Africa. A History and Description of the British Empire in Africa.' By Sir Harry Johnston, G.C.M.G., etc. London: National Society. 1910. 10*s.* 6*d. net.*

The National Society, in designing a series of volumes concerning Britain beyond the seas, made a good start in getting Sir Harry Johnston to write the 'History and Description' of the African dominions of the empire. In the compass of some 400 pages Sir Harry has found space, not only to give an account—necessarily summary—of each British colony and protectorate in Africa, but to take a broad survey of Africa as a whole and of its people. To his task Sir H. H. Johnston has brought qualifications not often combined in one person—great experience of equatorial Africa (both as explorer and administrator), an intimate knowledge of and sympathy with the negro races, and an acquaintance with the scientific aspects of the continent—its geology, zoology, and botany. It is these things, in conjunction with his study of the doings of other European nations in Africa, which give this work its distinctive value. It is not free from errors, especially in the South African chapters (which are, on the whole, less satisfactory than the rest of the book); but it is the best short account of Great Britain's record in Africa with which we are acquainted, with the possible exception of that by Sir C. P. Lucas—and Sir Harry Johnston's volume has

distinct advantages over the other work mentioned. It is not such "dry" reading, it is wider in its scope and outlook, it is more "up to date," and it is richly illustrated. It is not simply chronological and statistical—for such purposes other books serve better—but it discusses broad issues, and gives prominence to the causes which have impelled Britons (and Dutch) to seek to build up new communities in Africa or to exploit new markets. In a word, it is a very human book. On the other hand, the physical conditions—topography, fauna, flora—upon which largely depends the future of any country, receive adequate treatment. The reader of Sir Harry Johnston's pages will be able to form a definite idea of each of the regions of which he treats.

F. R. C.

'East Africa (British).' Compiled by Somerset Playne: edited by F Holderness Gale. (London: Foreign and Colonial Publishing Co. 1908–9. Pp. 443. *Illustrations and Diagrams.*) This sumptuous volume, though not an official publication, has been compiled by an authority who had the advantage of official assistance, besides being intimately connected with the country. The history, people, commerce, industries, and resources are dealt with in great detail, and many of the chapters are from the pens of specialists. Geography and geology are not dealt with as such, but the appearance of the different regions can be gathered in a certain measure from many photographs. Several branches of the work (especially economics and industries) are so highly detailed that they must quickly pass out of date, but in general outlines the book will form a valuable guide through many years of development. The Uganda railway is the subject of a particularly interesting chapter, but when will engravers realize that a map cannot be reduced beyond a certain point without becoming illegible?

AMERICA.

The Argentine Republic.

'Argentina.' By W. A. Hirst. London: Fisher Unwin. 1910. Pp. xxviii., 308. *Map and Illustrations.* 10*s.* 6*d.*

What with the South American series, to which this volume belongs, and with other books of the same class, the South American republics will presently be better served by general geographical treaties in English than any other part of the world. One would welcome more of them elsewhere (for the members of the Empire, for example), but presumably the sum of British and American commercial interests in South America accounts for the preponderance. In the present volume, a good example of its type, the country is first briefly but clearly described, a distinction being drawn at the outset between the four physical divisions—Patagonia, the Andine region, the Gran Chaco, and the Pampa. Eight chapters of history lead up to the present condition of the republic, its constitution and government, and (in great detail) its economic condition. There are also some purely descriptive chapters dealing with special features, among which that on the trans-Andine journey, beyond Mendoza, into Chile, is of particular interest in view of the recent completion of the summit tunnel on the new railway. One would gather that this line has been, in a sense, built for posterity; the author doubts its capacity to earn a profit for many years, and foresees great difficulty in keeping it open in winter. Incidentally his view of the disappointing character of the scenery is itself rather disappointing. On the railway system of the republic at large, its past and its future, the author writes one of his most interesting chapters. But the whole book is eminently readable, and the author's sane and restrained views as to the future, on many subjects, such as industrial prospects, town-planning, and the like, are a

noteworthy feature. There is a long introduction, highly laudatory, of the country and its prospects, by Major Martin Hume, whose death has deprived the series of its editor. For the rest, the book is copiously illustrated with photographs, contains a fair map, and is adequately indexed.

AUSTRALASIA AND PACIFIC ISLANDS.

Botany of Stewart Island.

Report on a Botanical Survey of Stewart Island.' By L. Cockayne, PH.D., etc. New Zealand: Department of Lands, Wellington. 1909.

"An actual piece of primæval world," such is the description of Stewart island by Dr. Cockayne, who waxes quite enthusiastic over the natural beauty of it. It is indeed rare nowadays to find an island almost untouched by man within the cool temperate belt, and the present report is certain to arouse the attention alike of the geographer, the botanist, and the zoologist. A great debt is owing to the Government of New Zealand for endeavouring to survey and preserve the whole or part of the island as an historic monument. It should be of especial interest to us, since, to all appearances, it strongly recalls western Scotland in point of climate and general conditions. As being the first comprehensive account of Stewart island, the present report assumes a particular importance.

Stewart island is separated from the southernmost point of New Zealand (South island), by the 15 miles of shallow water forming Foveaux strait. Roughly triangular in outline, with an extremely indented coast, and a hilly surface, it is largely built of crystalline and metamorphic rocks, and has been partly sunk after a period of upheaval, accompanied by glaciation. The climate is very rainy, and uniformly cool temperate, which is due to its situation within the belt of westerly gales. To these violent and frequent winds are due not only the heavy rainfall, which makes the island fundamentally a forest region, but also the distribution and aspect of plants and plant formations. Thus the timber limit is kept very low, tree growth frequently assumes the shape of scrub, with an aspect of elfin woods, the exposed portions are left treeless, and a very large proportion of the woody growth, being stunted and straggly, is unfit for the saw.

Behind a girdle of tangled coast scrub which extends even over the dunes, the undulated lowlands are variously occupied by boggy meadows, low or infra-aquatic moors and swamps, and several types of marshes, whilst the fairly well-drained and sheltered slopes and rises are covered with forests. Up to 1000 feet of altitude, the hills and mountains are almost entirely wooded. Corresponding to and typical of the climate is the Rimu forest. The coniferous rimu (*Dacrydium cupressinum*) is a valuable tall slender tree, with a drooping crown and a yellowish-green foliage. It makes fairly light stands of true cool temperate evergreen rain forest. On deep and boggy grounds the rimu is replaced by forests of yellow pine, another *Dacrydium* with a drooping, birch-like aspect. These forests are remarkable for the development of huge round cushions of mosses and liverworts, sometimes so crowded as to cover and hide the damp floor. Within the zone of maximum wind, forests degenerate into impassable and twisted gnarly tangles, which in their turn pass into no less formidable elfin scrubs and alpine moors, alternating with peat moors. The vegetation forms enumerated and briefly sketched are sure to awaken the interest of phytogeographers.

This flora is almost identical with that of the southern part of New Zealand, 467 out of 491 species being common to both sides of Foveaux strait. Yet the absence of some remarkable plants like the Antarctic beech (*Nothofagus*) calls for explanation, and the problem is whether Stewart island was actually part of the

mainland within recent times, or whether it was colonized by winds, currents, and birds. The botanical and zoological evidence as developed by Dr. Cockayne remains inconclusive, but the geological evidence appears to be stronger in favour of a recent land connection. The materials so ably presented here call for further study. The writer eloquently advocates the exclusion of all new plants and animals likely to effect a change in the original conditions. Certainly no better field could be desired for the study of the secrets of Nature at home, and the plea put forward by Dr. Cockayne deserves to be endorsed by all botanists, zoologists, and geographers, especially in view of the fact that the economic resources are so limited.

M. H.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Physiography.

'Physiography: Shorter Course.' Salisbury. 1909. John Murray. 6*s*.

The review of the longer work in the *Geographical Journal* for March, 1908, makes a long account of this abridged edition superfluous. Perhaps the most striking feature is the wealth of plates and text figures, many of them maps, which give the book a very great value for teachers enterprising enough to try to make the subject real to their scholars. The lavish illustrations necessarily curtail the text to an extent that prevents the book from becoming a substitute for the teacher's efforts. As in the larger book, the author treats the question of surface relief first, proceeding thence to the general study of the Earth as a whole. After discussing its motions, the facts ascertained are utilized for studying the atmosphere and climate. A short and rather weaker section on the ocean concludes the book.

Every teacher must select the order of treatment which makes the sequence of reasoning clearest in his mind, but it is questionable whether climate can be profitably studied before the oceans are dealt with. Otherwise the succession of subjects seems admirably carried out, and the idea of taking the cosmic study of the Earth after treating the smaller-scale facts of its relief may be singled out for special praise.

The author has included as a text figure a map of the Gulf of Avranches, showing the Channel islands as remnants of more extensive tracts. Some objection may be taken to the statement that it shows sinking during historic times, for the outlines shown have been ascertained by scientific inference, and, according to the recent calculations of Mr. Joseph Sinel, correspond to conditions several thousand years ago. The disputed term "monadnock" is defined as hard rock which has remained as hills or mountains after the weaker rock about it has been removed by erosion, and from the examples it is obvious that the author classes here such igneous masses as Le Mont Saint Michel, as well as mountain masses standing sharply out of a peneplain. A quaint argument is used in one place in discussing the advantages and otherwise of lakes to mankind, it being stated that agricultural land to a value of hundreds of millions of dollars would be available if Lake Michigan did not exist. One wonders what comment Chicago landlords would make.

H. J. F.

GENERAL.

Travel Sketches.

'Accidents of an Antiquary's Life.' By D. G. Hogarth. Demy 8vo. pp. x., + 176. *With* 40 *Illustrations from Photographs*. London: Macmillan. 1910.

The "Wandering Scholar" is well known among geographers, and he has wandered far, and into fresh fields, since his former travel-sketches appeared in

1896. This second collection, though it deals mainly with journeys undertaken since that date, draws also on the earlier period, and affords material for comparison in point of form and style. Distance, on the whole, has lent enchantment; the artist's touch is surer, his outlines sharper—though in that clear air they must needs be sharp if a man can see at all—his colours, if anything, stronger. The same personal note, half ironical, and a trifle cynical, runs through the whole; strongest in the odd "Apology" of apprentice days, and in the plainspoken chapter on "Digging"; all but cast aside when the explorer is most nearly in the place where he would be, on the real edge of the unknown, in mishandled Myra, or at the Chimæra's firehole, or among the splendid tomb-fronts of Cyrene. It was no small "accident," too, which set our antiquary on a magic transport like the *Utowana*, whose owner's sole preoccupation would seem to have been to lay his yacht alongside some quite first-class and otherwise quite unattainable site.

It need hardly be noted that these "accidents" are not wholly pacific; the antiquary turns war-correspondent in Thessaly and in Crete, and throws odd side lights on the perennial comic-opera of Levantine politics. He turns geologist also at need; the graphic account of the wash-out at Zakro is one of the best things in the book, and the cliff scene at Hierapolis one of the best of the pictures: note, too, the sketch of the business-end of a delta—land passing into water, so that the boats unload on to camel-back in the offing. But always he is geographer and anthropologist, whose "accidents" are at the same time steps in a large research, and whose journals and ready memory enlarge knowledge and focus experience at a hundred points. To write a book like 'Eothen' is perhaps as impossible now as it would be to make Eastern water-colours like Edward Lear's. But it is meant as commendation if I call Mr. Hogarth's book "photographic," and add that his fine plates are wholly "in the picture" with the text.

J. L. M.

'Der Orient, eine Länderkunde.' By Ewald Banse. (Leipzig: B. G. Teubner, 1901. Pp. 237. *Illustrations, maps, and diagrams.*) The set of booklets included under the general title of 'The Orient' forms part of the extensive *Aus Natur und Geisteswelt* series, which has already run to about 280 volumes, and is still in progress. The three under consideration, all printed, paged, and sold separately, are: I. 'The Atlas Lands,' giving a condensed but clear account of the geographical features, inhabitants, and economic relations of Morocco, Algeria, and Tunis. II. 'The Arabian Orient,' which deals in the same way with the Sahara, Tripoli, Egypt, Arabia, Syria, and Mesopotamia. III. 'The Aryan Orient,' comprising Asia Minor, Armenia, and Irania.

To the same series belong—

'Die Sprachstämme des Erdkreises,' pp. 144, and 'Die Haupttypen des Menschlichen Sprachbaues,' pp. 156, both by Dr. Franz Finck. (Leipzig: 1909, 1910.) These are uniform with the foregoing, and give from the standpoint of the latest investigations a comprehensive survey of the chief linguistic families. Dr. Finck briefly describes the great divisions—Caucasic, Mongol, Negro, and American—and endeavours to reduce them to primordial unity. But the attempt is necessarily a failure, as all such attempts must ever be.

'Die Kultur der Araber.' By Dr. Joseph Hall. (Leipzig: 1909. Pp. 144. *Numerous Illustrations and Two Tables*). A rare specimen of condensation, in which the author has managed to convey a surprising amount of information on Arab culture both before and after the advent of Mohammed. How under Islam the Arab hosts rapidly overran half the civilized world, and spread their language from the Atlantic to Central Asia, is clearly explained.

'Short Manual of the Amharic language.' By Major J. P. Alone. (London: 1909. Pp. 114. 5*s*.) A little essay on a very difficult form of speech, which the author has prepared for the General Staff. There is a copious English-Amharic vocabulary, and also a clearly printed table of the curious syllabic alphabet of the language, which is a degraded member of the Geez (Himyaritic) family imported into Abyssinia from South Arabia over two thousand years ago.

'The Statesman's Year-book.' Edited by J. Scott Keltie and I. P. A. Renwick. (London: Macmillan. 1910. Pp. civ., 1404. *Maps*.) The forty-seventh annual volume of this publication contains no important departure from precedent, while maintaining its standard of utility. The preface informs us of certain conversions from foreign to English measures, which are moves in the right direction. There are several important maps. The development of Belgian Congo is illustrated, as also the movement of urban and rural population in the United Kingdom, the course of the proposed Clyde-Forth and Georgian Bay canals, the union of South Africa, new South American frontiers, and the federal district and capital of Australia. The valuable bibliographies bear the usual marks of careful revision to date.

THE MONTHLY RECORD.

EUROPE.

"Transhumance" in Spain.—An admirable sketch of the history and conditions, in Spain, of "transhumance," or the periodic movements of sheep between their summer and winter pastures, has lately been contributed to the *Annales de Geographie* (May 15, 1910) by Mr. A. Fribourg. Spain, it is pointed out, is one of the countries in which the natural conditions—the violent contrasts of relief, soil, climate, and consequently of vegetation—are specially calculated to foster such movements. While one district is burnt up by the summer sun, another, at no great distance, will be clothed with luxuriant grasses, and it thus comes about that, at every season, the animals are sure to find in some part or other the vegetation necessary to its existence. The past history and social condition of Spain likewise fostered the development of the system. The incessant wars and disturbances favoured stock-rearing rather than agriculture, the mobility of flocks and herds enabling them to be moved to a place of safety in the case of a hostile inroad. When, in due course, the inevitable conflict of interest between herdmen and agriculturists arose, the former enjoyed a long continuance of royal protection, and special privileges were secured by the "Mesta" or association of owners of flocks—only to be abolished during the first half of the last century. Thenceforth the migratory movement declined, and statistics published in 1892 showed that the numbers of sheep, subject to periodic change of pasturage, were then only half what they had been in 1482, and only about one-tenth of the total number of sheep in the kingdom. Mr. Fribourg shows by a pair of sketch-maps (1) the total distribution of sheep in Spain, and (2) the distribution of migratory sheep. While the two distributions show a broad general resemblance, both being, *e.g.*, far more intense to the north than to the south of the parallel of 40°, there are important divergences in detail. Thus, while the mountainous and well-watered province of Navarre, with a large actual number of sheep, shows no migratory movement at all, the neighbouring province of Huesca, with a much smaller total, shows a particularly strong movement, owing to the attraction exercised by the vast winter pasturages on the banks of the Ebro. Broadly speaking, the main centres of migration are

regularly distributed on either side of the more important areas of winter pasturage, as is well brought out by a coloured map which accompanies the article. This shows also the main routes followed by the moving flocks in the past, grouped under three main divisions, the most important (at least, for the length of the routes) being that of the north-south movement across the central Meseta. Within the last few years the whole system has been revolutionised by the facilities introduced by the railway companies for the rapid transport of sheep by rail over long distances. This has caused the old historic routes to become well-nigh deserted. The writer concludes with a brief comparison, in respect of "Transhumance," between Spain and other Mediterranean countries in which it is practised.

The Hydrography of the Arno Basin.—A monograph by G. Canestrelli, entitled "Materiali per lo Studio dei Fiumi Italiani. I. Le Regioni a Spartiacque incerto od indeterminato dei bacini dell' Arno e del Serchio," constitutes No. 7 of vol. 3, 1909, of the *Memorie Geografiche*. The treatise is essentially a historical survey of the variations which the hydrography of the region has undergone within historical time. A number of river and lake basins in connection with the Arno system are discussed in close detail, including the Val-di-Chiana, the classic lake Trasimene, and the Pisan plain; and attention is devoted to the changes which the direction of flow, location of watersheds, and water-level which the different water systems have undergone as a result of the agency of man. The investigation is too minute to interest any one without local knowledge of Tuscany. The Val-di-Chiana, one of the districts discussed, is an extensive valley running in a southerly direction from the hills of Arezzo to those of the Città della Pieve. It is bounded on the east and west by fertile hills, and is open at the northern extremity towards the basin of the Arno and at the southern towards the basin of the Nestore, a sub-tributary of the Tiber. The plain of Chiana itself is traversed lengthways by the Maestro canal, which gathers the waters of numerous streams and torrents from the surrounding hills, directed by a well-defined system of trenches, and carries them to the Arno *viâ* the narrow pass of the Ponte a Buriano. For so early but interesting a period as the Etruscan, historical documents are wanting regarding the Val-di-Chiana, but it may be surmised that the valley was fairly normal, since the Etruscans would not have had their habitat in an unhealthy marshy country, and the two neighbouring districts of Chiusi and Cortona were in a high state of agricultural and industrial prosperity. In the Roman epoch the Chiana (Clanis) flowed swiftly southwards into the Tiber, but subsequently hydraulic disorders were observed, resulting in the development of a marshy condition of the region in the thirteenth and fourteenth centuries. After this period another *régime* gradually succeeded, in which the Arno and Tiber seemed to be fighting for the tribute of the Chiana. At first the tributary portion of the Tiber was much the longer, as the designs of Leonardo da Vinci and others abundantly show, but later on the Arno gained the supremacy owing to the accumulation of torrential deposits to the south of the region. Thus the existing *régime* was brought about, and now engineering work, as indicated above, facilitates the passage of the Val-di-Chiana watercourse into the Arno.

Prof. Garwood's paper on Features of Alpine Scenery: Erratum.—In the *Journal* for September, p. 338, line 28 from top, for "sheltered" read "shattered."

ASIA.

Indian Scientific Work.—The Annual Report of the Board of Scientific Advice for India for 1908-09 is bulkier than usual, and contains a remarkably varied tale of work. Mr. Gilbert T. Walker, Director-General of Observations,

contributes three reports on researches in solar physics, meteorology and terrestrial magnetism. The geological chapter by Sir Thomas H. Holland, Director of the Geological Survey, covers fifty pages. Under the head of Mineralogy is noticed the discovery of several new varieties and species of minerals characterized by the presence of manganese in small or large quantities. Among economic inquiries importance attaches to Mr. Murray Stuart's discovery of kaolin in the Rajmahal hills, suitable for the manufacture of china and porcelain. In one locality the quality of the clay is good, strongly resembling the Cornish china clays, and the quantity, speaking from a manufacturer's point of view, is unlimited. In three of the coalfields in these hills Mr. Murray Stuart lighted on some deposits of excellent fire-clay. These are, however, difficult of access at present and not very large. Under the head of Geological Surveys there is a variety of work achieved by Dr. Pilgrim in Baluchistan and Mr. Middlemiss and Mr. Datta in Kashmir and the Central Provinces, but the results and conclusions arrived at do not admit of any striking generalizations. The report on geography and geodesy contains a brief review of Dr. Stein's and Surveyors Ram Singh and Lal Singh's surveys in Chinese Turkistan and Kansu. There is a detailed list of the various surveys carried out, independently of Dr. Stein's own route between Mastuj and Leh, which amounts to a total distance of some 6500 miles. A table of eleven positions in the Tarim basin shows the difference between the values as determined by Dr. Stein's surveyors and those previously accepted. Dr. Stein's map consisting of ninety-four sheets is now being drawn at the Trigonometrical Survey Office, Dehra Dun, on the scale of 4 miles to the inch. The information therein will eventually be incorporated in the survey of India maps. The invar wire measuring apparatus (see *Geographical Journal*, vol. 34, p. 340) ordered from Paris has been received, and an alley 97 feet in length is now being constructed in the grounds of the Trigonometrical Survey Office, in which a base 24 metres long will be laid down. The base will be laid out by means of the new 4-metre invar standard bar, now being manufactured at Geneva. In each of the end walls a frictionless pulley will be fixed, over which the wire to be tested will be strained. During 1908–9 four detachments were employed on principal triangulation, and in consequence the additions made to the Geodetic Survey have again been large. In all a length of 270 miles of triangulation covering an area of 9600 square miles has been added. The districts in which the detachments were at work were Northern Baluchistan, Shan States (Burma), and Kashmir. In May, 1908, Lieut. Oakes commenced the Northern Baluchistan Series, starting from the Kalat Longitudinal Series, and, working along the meridian 66° 31′ E., carried the new series northwards to 31° N. Hence onward the series will take an easterly direction, following as closely as possible the Afghan-Baluchistan frontier, and eventually closing on the great Indus Series. Mr. Tresham and Lieut. Cardew continued this work, the latter executing 50 miles of triangulation enclosing an area of 1900 square miles. In Burma, Captain Browne continued the Great Salwen Series, carrying the new triangulation forward for a distance of 120 miles, a small outturn due to the monsoon rains, heavy mists and, later on in March, dust haze, which compelled a stoppage of the work. In Kashmir Mr. de Graaf Hunter has started a new series which emanates from the North-West Himalaya Series It is proposed to run this series north as far as Gilgit, where it will trend eastward and meet the old triangulation. The latter, a magnificent work, which was carried out by the late Major T. G. Montgomerie, R.E., between 1855 and 1861, will be revised southwards. This contemplated work will prove a formidable task, many of the proposed stations being at altitudes of 16,000 feet and over,

while two at least are above 18,000 feet. When completed the series will form the most northerly extension of the principal triangulation of the Great Trigonometrical Survey of India, and the stations will far exceed in height those of any principal triangulation yet executed.

Japanese Annexation of Korea.—By a treaty between Japan and Korea, signed on August 22 and promulgated a week later, the former acquired sovereign rights over the peninsula, which has therefore ceased to exist as a separate state, being henceforth incorporated with the rest of the Japanese empire. The official designation will in future be "Chosen," though it is hardly to be supposed that the old familiar name will at once fall into disuse. By a declaration to the Powers, made simultaneously with the promulgation of the annexation treaty, Japan has agreed to continue without change, for a period of ten years, all commercial rights enjoyed by foreigners in the country. The existing consular courts are, however, abolished.

AFRICA.

The Murder of Lieut. Boyd Alexander.—An inquiry instituted by the French authorities has elicited some further details respecting this regrettable occurrence, though not of a character to alter the general impression conveyed by earlier reports. They only serve to emphasize the courage and determination shown by the traveller in his endeavour to press on in spite of all obstacles, when the safer course would have been to wait until the way became clearer. He had left Fort Lamy (on the Shari) on December 30, 1909, and travelling *viâ* Moito, Yao, Birni, and Birket el Fatma, reached Abesher, the capital of Wadai, on March 4. Dissuaded by the French officer in charge at Abesher from continuing his journey at once, he had communicated with the Sultan of Darfur, announcing his intended passage through that country; but learning meanwhile that Dar Tama (claimed by the French as belonging to Wadai) had been invaded by Darfur troops, he obtained facilities for a visit of inspection in this direction, the French officer understanding that he would return shortly to Abesher. Setting out on March 28, he pushed on to Dar Tama, in spite of the remonstrances of the native official who accompanied him, and reached a small village close to Nieri, on April 2. The cause of the fracas in which the traveller met his death seems to have been correctly given in the earlier reports—viz. his resistance to the attempt to take him by force before the Sultan of Dar Tama. One of his men fell near him with a wound in the head, and, after the retirement of the assailants, crawled to the spot where his master lay and assured himself of his death, afterwards making his escape. The facts are substantiated by the testimony of seven out of the eight men in the service of Lieut. Alexander at the time.

The French Occupation of Adrar.—The recent French campaign in Mauritania * formed the subject of papers read before the Société de Géographie on June 10 last, and printed in the August number of *La Géographie*. The military movements of the column under Colonel Gourand were described by Captain Dupertuis, while the colonel himself explained the geographical features of Mauritania and Adrar, and the events which led up to the campaign. The southern part of the area in question consists of immense sandy wastes, covered with dunes running mostly north-east and south-west, the direction of

* It will be remembered that the French province of "Mauritania" is very different from the ancient region of that name, being the extreme western portion of the Sahara north of the Senegal.

these being, of course, caused by the prevailing winds. In other parts the dunes run in more irregular fashion, while elsewhere again are found the plateaux of Tagant and Adrar, traversed by deep ravines. Adrar may be described as a sort of rocky citadel rising from a surrounding wilderness of sand. The mountains present a somewhat gloomy appearance, but contain the riches and resources of the country, such as they are. There are about forty palm-groves and oases, some of considerable extent; that of Atar, the capital, is a day's journey across. Dates, wheat, and barley form the principal crops. Adrar is much better watered than other districts of Mauritania; the capital, like the three other *ksur* or towns, viz. Chingweti, Wadan, and Ujeft, consists of stone-built, one-storeyed houses, of fairly solid construction, with terraced roofs. With the exception of the inhabitants of these *ksur*, the population of Adrar is entirely nomad. The climate is healthy and bears that reputation among the Moors; with the French troops it has proved very recuperative to those suffering from the privations of the campaign. The population consists of Moors—as the French apply the term—a hybrid people resulting from a mingling of Arab and Berber races; their language, in like manner, is a mixture of the two tongues. They are lean, dry, very energetic, capable of determined resistance, and of savage temperament, particularly in the case of those who dwell in the interior, far from the chief river. As to their courage in battle, opinions differ somewhat; the fact being that it appears to be tempered with a good deal of discretion, according as they fancy themselves to be inferior in numbers to their adversaries. When General Faidherbe occupied Semyak he found himself confronted by the same Moors, but in those days they were poorly armed, whereas now they have plenty of repeating rifles, which are now smuggled into the country from the coast on the north-west and through Morocco on the north. The need for the French expedition arose from a condition of things common on the borders of civilization, viz. frequent frontier raids. The fact that the raiders were able to escape on camel-back into the heart of the Adrar country, where arms, ammunition, and food were always procurable, made peace along the border an impossibility. After sustaining serious losses in 1908, the French Government reluctantly came to the conclusion that to refrain from annexation was no longer possible. The military operations were not prolonged, Atar being captured on January 9, 1909, after which desultory fighting took place in various directions. The crowning success took place on August 15, at Turine, in the north, where 2000 camels were captured.

AMERICA.

Explorations in North-Western Canada.—One of the most important of the hitherto unexplored areas in Northern Canada has lately been traversed by a line of survey carried out by Mr. Joseph Keele, of the Canadian Geological Survey. A report on the journey has this year been issued at Ottawa (Government Printing Bureau, No. 1097). The area crossed by the route lies between the Yukon and Mackenzie basins, being drained by the upper Pelly and its branches on the side of the former, and by the Gravel river on the side of the latter. It embraces a great tract of highlands (forming part of the backbone of North America), to which the general name Mackenzie mountains has been given. The central portion of this tract had previously been quite unknown, though during the rush to Klondyke a party is said to have made its way across the mountains, amid great hardships, from the Gravel river to the Stewart tributary of the upper Yukon. Having, in the early summer of 1907, made an examination of the main Pelly for 140 miles above its confluence with the Ross, and disproved the reported existence of an active volcano in that region, Mr. Keele

started on the main journey later in the same year, ascending the Ross branch of the Pelly to the limit of navigation, and thence crossing the divide by a winter sledge-journey to the head of navigation on the Gravel river. During the journey no person was seen until the Mackenzie was reached, except a small band of wandering Indians at the head of the Gravel river. As a result of his survey, supplemented by previous work for certain outlying portions, Mr. Keele has constructed a useful general map of the whole region, while a lucid sketch of its main geographical features is also supplied in the letterpress. The two main topographic types of the Cordillera in Southern Canada have their counterpart in this region, the Yukon plateau (bordering the Lewis and Yukon rivers) corresponding to the interior plateau region of British Columbia; while the higher and more rugged mountains to the east represent the north-western continuation of the Rocky mountains proper. The plateau seems to have the general character of a dissected peneplain, and the groups of mountains which rise above the general level (to heights, sometimes, of 7000 feet or more) seem the result of prolonged differential erosion, rather than the remnants of a former range, as was suggested by Dr. Dawson. These mountain groups are approached in some cases by spurs from the main eastern range, so that the western limit of the latter is not easily definable. This main range seems to be in a more youthful topographic stage than the plateau region. It presents a fairly massive front to the west, but its crest-line is uneven both in course and in profile. The structure is characterized by folding, and though the main drainage channels cut across hard and soft strata alike, many of the valleys are carved out of the soft strata. Towards the east fracturing, buckling, and faulting of the strata are more in evidence than in the west. The water-parting is not the most important element in the relief, and does not form a natural dividing-line between distinct topographic provinces. The two sides of the range differ greatly as regards river development and stream grades. The westward-flowing rivers flow by easy grades through valleys of mature erosion, while the Gravel river and its branches on the east descend rapidly to a much lower level in a far shorter distance. Precipitation being much greater on the west, the western streams are much more copious in proportion to the area drained. While June in this region is a perfect summer month, with temperature rising to 90°, in January, the coldest month, the temperature is seldom above zero, and often very much lower.

Carl Lumholtz's Explorations in North-West Mexico.—The American Geographical Society has lately received from Mr. Lumholtz some account of explorations carried out by him since May of last year in little-known parts of North-West Sonora and Southern Arizona. During a three months' journey in the deserts of this region (brought to a close at the oasis of Sonoyta, whence the information was despatched), he had travelled west to the Colorado, south to the Gulf of California, and north to the southern sierras of Arizona. He had made the complete circuit of the Pinacate region, and had visited the hitherto unexplored Sierra Blanca to the south of it. Travelling south from the Colorado along the coast, he lost most of his horses in the arid region of sand-dunes, it being possible to give them water only once in thirty-six hours on an average. The mules, and especially the donkeys, stood the want of water much better. There had been no rain during the winter, and the "tinajas" or water-holes were drying up. The country explored is described in general terms as a great "arboreal desert," with numerous sierras, much worn down, running from south-east to north-west. The formation is granite and volcanic. The southern part is traversed by a belt of sand-dunes, parallel to, but at a little distance

from, the sea, reaching in the west a height of 185 feet or more. Although the area in question is described as little known, it would seem to have been traversed in many directions by the Jesuit and other missionaries in the eighteenth century.

Railways of Colombia.—A useful sketch of past and present railway enterprise in Colombia is supplied in a Consular Report (Misc. Series, No. 678) by Mr. V. Huckin. The first railway laid in Colombia was that connecting Barranquilla with the sea, in 1867. It has played an important part by opening Barranquilla to the trade of the Atlantic seaboard, but it may be vitally affected by the present project for the cutting of the dangerous bar at the mouth of the Magdalena (passed by Congress in 1909), which would convert the town of Barranquilla from a river to an ocean port. The Antioquia railway was commenced in 1874. The Cauca line, begun in 1878, had to the end of 1908 advanced only 41 miles, but is now making rapid progress towards completion. The Cucuta line was taken in hand in 1879, and is now, after many years' stagnation, likely to profit largely by the re-opening of the river Zulia. From 1881 dates the beginning of the Santa Maria, Girardot, Dorada, Northern and Sabana lines. Between 1892 and 1894 the Cartagena railway was constructed. In 1895 work was begun on the Southern and Tolima lines. Between 1905 and 1907, the Dorada Extension, the most rapid, as also probably the best piece of work in the country, was built. A commencement has also been made of a line to connect Bucaramanga with the Magdalena. The twelve lines now in operation, varying in length from 82 to 16 miles, measure in all fully 560 miles. They include, among others, the three lines leading to and from the three principal Atlantic ports, and the three lines connecting Bogotá with different parts of the Sabana.

Glacier Exploration in the Andes.—In the *Zeitschrift für Gletscherkunde*, vol. 4, part 3, Dr. F. Reichert gives an interesting account of the peaks and glaciers of that section of the main range of the Andes lying between Mounts Aconcagua and Tupungato. He has himself made four journeys to this region, partly in company with other German travellers, and his account is in great measure based on his own observations. While both Aconcagua and Tupungato have been fairly well explored, and their neighbourhood surveyed in connection with the Argentine-Chilean boundary, the greater part of the intervening stretch has remained almost unknown ground, though, as Dr. Reichert says, it includes a mountain massif which for its height and vast development of glaciers may be classed among the most stupendous of the whole Cordillera. Dividing the whole area dealt with into three groups (those of Aconcagua, Juncal, and Tupungato), separated by the Cumbre and Morado passes, he describes each in detail, the two last being those with which his own explorations have been most largely concerned. The upper region of the Juncal group remains still almost virgin ground, but Dr. Reichert has been able to throw a good deal of light on its glacier system.* The massif is intensely glaciated both on the south-east and south-west sides, and one glacier in particular, on the east, has an enormous collecting-ground, the trunk stream being formed by the junction of quite a number of subsidiary glaciers coming from three distinct groups of peaks. This, and others on the eastern side, carry their tribute to the Rio Plomo, a branch of the Tupungato which is even of more importance than that river itself. The ascent of the Cerro Juncal would involve great difficulties. The Tupungato group includes, besides Tupungato itself, the more

* As mentioned in the *Journal*, vol. 35, p. 336, Dr. Reichert started at the end of last year, with several coadjutors, for further exploration of the Juncal group.

northerly Polleras, a massif which falls little behind the Juncal in its bulk, height, and glaciation. Little more than the name had been known until Dr. Reichert's visit in 1908, but though three times baffled in his attempts to ascend it, the traveller was at last rewarded with success on attacking it from the west, completing the climb on February 5 of the year named. The largest of its glaciers has a length of nearly 5 miles. This group, too, supplies a large amount of water to the Tupungato. The glaciers of Aconcagua and Tupungato fall far behind those of the intermediate section of the range, which can show twelve imposing glaciers in the Juncal massif and four in that of the Polleras.

AUSTRALASIA AND PACIFIC ISLANDS.

Papua in 1908–9.—A report on the affairs of Papua for the year ended June 30, 1909, by J. H. P. Murray, its lieut.-governor, tells of the prosecution of the delimitation of the Anglo-German boundary. The work of fixing the position of the 8th parallel of S. latitude, as common boundary for some distance, begun on January 7, was expected to be finished in October, 1909. A tracing shows work done by the British Commissioner, January to July, 1909. The officers' divisional reports embody a good deal of geographical information. The demand for land continues, and the extent of land open to settlement in Papua is practically unlimited. A large area of land in Collingwood bay has been taken over as a rubber plantation. Settlement, however, continues to be attracted chiefly to the central and eastern divisions, comprising as they do Port Moresby and Samarai. But there is no lack of good land elsewhere. The Mambere flats, in particular, between the main range and the sea in the Kumusi division, are perhaps better land than most of that already taken up. The four Government nurseries have been suffering from dearth of labour, and three of them were to be worked in 1909–10 by prisoners. Mining had not been very prosperous during the year. The amount of copper ore exported shows a shrinkage from 175 to 67 tons. Yet the outlook is brighter than ever before, shafts recently sunk attesting the permanence of ore at these points. An area has been chosen for a Government stud farm for the breeding of horses. The road from Port Moresby to the Sogeri district has been pushed forward, and also a road from Kulumadan to Busai on Woodlark island, and a road from Rigo to Saroake on the Kemp-Welch. Rest-houses are being erected on roads at intervals of from 10 to 12 miles. Public buildings have been erected at Port Moresby, and progress has also been made in the matter of buoys and beacons.

The British New Guinea Expedition.—We are pleased to learn that the financial difficulties which stood in the way of the further prosecution of the work of this expedition have been removed by the grant by Government of £4000 to the funds of the expedition.

Dutch Exploration in New Guinea.—The Dutch authorities in the Far East continue to pursue the exploration of the western part of New Guinea with great energy. Besides M. Lorentz's expedition to the Snowy range running parallel to the south coast, several important river expeditions have lately been carried out, and have materially extended the bounds of knowledge towards the hitherto unexplored interior (see various maps in the *Tijdschrift* of the Netherlands Geographical Society for the present year). One of these, under the leadership of Captain A. F. Herderschee, directed its attention to the great Mamberamo river in the north-west (the Amberno of some maps), which had also been the object of a reconnaissance by Lieut. Rambonnet in 1909. It was hoped that this river might afford a feasible route towards the great interior

range, attempts on which had hitherto been made from the opposite side only. In November, 1909, the expedition began the ascent of the river in a small steamer—the *Pioneer*—meeting with some difficulties owing to the strength of the current during the passage through the mountains, which compelled the explorers to take to canoes. By establishing advance camps on the upper course progress was gradually made, and it was found that the river, which in the mountain section had a breadth of some 200 yards, widened out into a placid stream of 500 yards and more when the great interior plain was reached. Just north of 5° S. lat. an important branch coming from the east was discovered, but Captain Herderschee followed the western branch, which took him in a south-westerly direction to the foot of the central range. In lat. 3° 23′ 34″, long. 137° 28′ 48″, rapids once more hindered progress, and, the party being now apparently only some 45 miles from Mount Carstensz (the goal, it will be remembered, of the British expedition from the south coast), an attempt was made to push on on foot. But a severe outbreak of beri-beri and malaria among the personnel of the expedition forbade a further advance, and Captain Herderschee was reluctantly compelled to order a return (April 4, 1910). The result of the expedition has been to show that the Mamberamo may be utilized as a means of access to the interior, though the unhealthiness of the country it traverses (a large part of which is a vast swamp) would make a long stay therein undesirable. On the southern side of the island progress has been made with the survey of the Digul and other rivers draining the area west of the 141st meridian. The Digul, which probably has the longest course of any of these, was ascended towards the end of last year by a party under Lieut. Nijweide (acting under the orders of Mr. Resident Hellwig), to a point in about 5° 20′ S. lat., half a degree west of the international frontier. A hill was ascended whence a view was obtained of the central chain of mountains, including the peak known as Mount Juliana (a considerable distance east of Mount Wilhelmina, reached by Dr. Lorentz). This was ascertained by triangulation to have a height of about 4500 metres (nearly 15,000 feet), and showed distinct patches of snow at the time. (A sketch of the peak and panorama of the whole range are given in the Dutch *Tijdschrift* for September of this year, which also contains a general map showing all the results of the recent explorations.) The range, which seems to be connected eastward with the mountains bounding the basin of the Fly on the north, was seen to consist of several distinct chains. Another river lately explored by Mr. Hellwig and his assistants is the Island river, which enters the sea in about 5° 45′ S. It expands in places to a considerable width, and was traced upwards, in the direction of Mount Juliana, to within about 50 miles from that summit.

The German-Dutch Boundary Commission in New Guinea.—Some details respecting the experiences of the joint expedition for the demarcation of this boundary (*Journal*, vol. 34, p. 683) are given in the *Deutsches Kolonialblatt* for September 15. Writing on July 20, Prof. L. Schultze, the leader of the German survey party, reports that a start from the coast along the meridian of 141° E. was made on June 12. Keeping touch with the Dutch party, the expedition (after sending home one of its members invalided) crossed with considerable difficulty a range of mountains over 5000 feet in altitude, and reached a wide plain traversed by a stream flowing between steep banks. Descending this, the explorers found it swelled by tributaries into a large river which took a westerly course. The natives proved hostile and thievish, and no intercourse with them was possible. Supplies could not be procured, and as no paths existed, the expedition was forced to turn back after reaching 3° 20′ S.

lat., in 140° 56′ E. long. Both sections proposed to make a new advance by way of the Kaiserin Augusta river (cf. *Journal*, vol. 34, p. 458), hoping to strike the 141st meridian again, and to continue the survey south of the point previously reached. A gunboat had been supplied by the Dutch authorities, and according to a later telegram the ascent of the river named has since been begun. The region explored seems to bear the same general orographical character as other parts of the north of New Guinea, a coast range being backed by a wide plain watered by rivers flowing more or less parallel to the coast. The westward-flowing river above mentioned would seem to be a headstream of the Mamberamo (see previous note).

POLAR REGIONS.

Captain Bernier's New Arctic Expedition.—Captain Bernier sailed once more in the *Arctic* for the northern waters of Canada during July. It seems that he has given up the idea of pushing north by way of Jones sound, his plan being to effect the North-West Passage by way of Lancaster sound and Melville island, returning through Bering strait.

Captain Scott's Expedition.—The *Terra Nova*, which reached Cape Town in safety, though slightly behind time, about the middle of August, sailed for Melbourne, with Captain Scott and other members of his expedition on board, on September 2. During the stay in South Africa a warm welcome was given to Captain Scott and his party, who were entertained at a banquet on August 24, while the sum of £500 was contributed by the Union Government to the expenses, and subscription lists were opened at Cape Town and elsewhere. The *Terra Nova* is expected to reach Melbourne about October 7, and will sail direct thence for Lyttelton, N.Z., without visiting Sydney, owing to the delay in the early part of the voyage. Dr. Wilson sailed in advance by mail steamer, in order to make final arrangements in Australia.

GENERAL.

The Development of Commercial Centres.—Attention may be called to a thoughtful and suggestive paper on this subject, bringing out clearly the leading conditions which govern the development of commercial centres, contributed by Dr. J. Russell Smith to the *Bulletin* of the American Geographical Society for May last. Though cities combine to a certain extent the characters of commercial or industrial centres, they exist in the main either as one or the other, and it is to the *rôle* of cities as distributing centres, and the various influences affecting them, that Dr. Smith directs attention. Advantage in transportation is of course the governing condition determining the site, and in former days the head of navigation on a river was one of the most commanding locations possible. But with the introduction of railways and giant ocean steamers the river-port has given way to the seaport, which is a focussing point of the commerce of both land and sea, though it must be at a point as far inland as possible, in order to take the greatest advantage of the cheaper freights possible on large ships. It must also have easy access to the land and the centres of population which it serves, and this gives a special advantage to ports near the mouths of rivers, not only on account of the river navigation, but because of the facilities supplied by river valleys for the construction of canals and railways. The most important factor in the development of a commercial centre is the existence of a large producing and consuming inland region, and the growth of an intermediary or distributing trade is a secondary step, which *follows* the establishment of transport lines giving connection with the various countries engaging in international trade. These are only built up, and in the main supported, by

local demand and local production, and the successive great distributing centres of the world all had important commercial activities of their own before controlling the commerce of other countries. An important recent development is the pronounced separation of ports into classes—the raw-material port and the manufactured-goods port. The growing development of trade in cheap and bulky articles has produced new conditions with less dependence on great ports and distributing centres. Full cargoes of goods like phosphate or lumber can be loaded at any small port near the place of production, and go direct to their destination. Thus, while the old commerce in costly articles—manufactures, spices, and luxuries—stays in the old centres, the new commerce goes directly between small ports. The trade of all ports acquires a one-sided character, and the greater number of the world's ports are either exporting or importing ports, the two activities being rarely maintained in anything like equal proportions in one and the same centre. In a country like the United States, which produces mainly raw materials, it is the small ports which show an excess of exports, the older, great ports, an excess of imports. In a manufacturing country like the United Kingdom, the reverse is the case.

John Cary as a Cartographer.—A paper recently read by Sir H. G. Fordham at a meeting of the Cambridge Antiquarian Society takes stock of the publications of John Cary, whose method of delineation, characterized by a delicacy and clearness all its own, has, it is claimed, dominated British cartography from the end of the eighteenth century to the present time. There exists in the British Museum a canal plan, signed by Cary, dated 1769, and in the volume containing this plan are others bearing his signature. G. and J. Cary's publications range from 1769 to 1836. "G. Cary" appears on the publications issued under the name of Cary between 1824 and 1836. There is no clue to the relationship between John and Francis Cary, the latter of whom engraved a large number of the plates in Gough's Edition of Camden's 'Britannia' (1789 and 1805). Of the smallest of the three sets of maps of the English and Welsh Counties published by Cary—the 'Traveller's Companion'—editions date from 1790 to 1824. The second set in order of size, 'New and Correct English Atlas,' appeared in 1787, and was republished in various editions down to 1821. Thirdly, in 1809 appeared the 'New English Atlas,' the maps of which were used in 1819, 1820, and 1821, for setting out the geological discoveries of William Smith. The plates of these three sets still exist, and the county maps of the Folio Atlas, more than a century old, are still published for the use of motorists. In his map of England and Wales of 1794, Cary was the first to substitute the meridian of Greenwich for that of St. Paul's. Leaving out of account individual maps incorporated into atlases, there are some 50 titles of works by Cary, and of individual maps and plans about 300.

CORRESPONDENCE.

Sugar Production in Mauritius.

In your issue for June, 1910, Prof. J. W. Gregory states on page 674, "There has been a decrease during the same period (1904–08) in many sugar-producing British colonies, including Mauritius, etc."

Although it has no important bearing on the point at issue—*i.e.* the possibility of developing the Australian sugar industry with white labour—it is well to be exact with regard to facts.

The output of sugar has steadily increased in Mauritius during the period

in question—indeed, there has been an uninterrupted increase since 1892—such variations as have occurred being due entirely to varying atmospheric conditions.

FROM THE MAURITIUS ALMANAC.

Year.	Sugar exported. tons.
1903–04	218,531
1904–05	137,899
1905–06	191,765
1906–07	211,464
1907–08	169,161
1908–09	211,464

The crop of 1909–10 yielded over 240,000 tons for export.

The normal yield during this period, or the yield corrected for the effect of seasonal changes, was as follows:—

Year.	Sugar exported. tons.
1903–04	182,000
1904–05	185,000
1905–06	188,000
1906–07	191,000
1907–08	194,000
1908–09	198,000

In 1892 the normal yield was only 120,000 tons.

Whatever may have been the effect of the employment of white labour in connection with the Australian sugar industry, it is certain that, under the existing economic conditions in Mauritius, the abolition of native labour would be attended with disastrous results.

A. WALTER.

[Mr. Walter's statistics confirm the statement in the paper. For such a locality as Mauritius the sugar exports are the best test for comparison, and Mr. Walter's figures show that of the years referred to, the sugar exports were highest in 1903–04. The exports of 1907–08 were 49,370 tons less than in 1903–04, or a fall of 22 per cent. The yield corrected for seasonal changes is too uncertain to be a satisfactory standard of comparison. Mauritius is represented by it as having exported more sugar than its yield in four years out of six.

The substitution of white labour for coloured labour in Mauritius was not suggested in the paper referred to, and the recovery of Mauritius from the period of depression in the sugar industry does not affect the argument based upon that fact.

J. W. G.]

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By EDWARD HEAWOOD, M.A., *Librarian*, R.G.S.

The following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are as a rule written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Col. = Colonies.
Com. = Commerce.
C.R. = Comptes Rendus.
E. = Erdkunde.
G. = Geography, Géographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
Jb. = Jahrbuch.
k.k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. (Mém.) = Memoirs, Mémoires.
Met. (mét.) = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. (Riv.) = Review, Revue, Rivista.
S. = Society, Société, Selskab.
Sc. = Science(s).
Sitzb. = Sitzungsbericht.
T. = Transactions.
Ts. = Tijdschrift, Tidskrift.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Balkan Peninsula—Geology. *M.k.k.G. Ges. Wien*, **52** (1909): 619–658. **Frech.**

Geologische Forschungsreisen in Nordalbanien, nebst vergleichenden Studien über den Gebirgsbau Griechenlands. Von Prof. Dr. Fritz Frech. *Illustrations.*

Bosporus. *G.Z.* **16** (1910): 65–73. **Braun.**

Ueber den Landschaftscharakter der Bosporusufer. Von Fritz Braun. *Illustrations.*

France—Cartography. *Ann. G.* **18** (1909): 193–204, 289–310. **Gallois.**

L'Académie des Sciences et les origines de la carte de Cassini. Par L. Gallois.

France—Charente-Inférieure. *B.G. hist. et descriptive* (1909): 281–296. **Pawlowski.**

Les transformations du littoral français. L'embouchure de la Charente inférieure et l'île d'Aix, d'après la géologie, la cartographie, et l'histoire. Par Auguste Pawlowski.

France—Isère. *B.G. hist. et descriptive* (1909): 205–222. **Ferrand.**

Le lac Saint Laurent. Son histoire: les erreurs commises sur sa durée. Par Henri Ferrand. *Facsimile maps.*

France—Landes. *G.Z.* **16** (1910): 82–102. **Kretschmer.**

Die Küsten der "Landes." Von Konrad Kretschmer.

France—Regions. *Ann. G.* **18** (1909): 1–12. **Gallois.**

Les noms de pays. Par L. Gallois.

France—South-West. *B.G. hist. et descriptive* (1909): 194–204. **Barré.**

La Provence dans le recueil des dessins originaux de Pascal Coste. Par H. Barré.

France—Vendée. *B.G. hist. et descriptive* (1909): 258–280. **Chauvigné.**

Géographie historique et descriptive du Bocage vendéen. Par Auguste Chauvigné. *Map.*

Germany—Black Forest. **Feucht.**

Vegetationsbilder (*Karsten & Schenck*) **7** (1909): Plates 13–18.

Der nördliche Schwarzwald. Von Otto Feucht. *Illustrations.*

Germany—Early Maps. **Wolkenhauer.**

Die Koblenzer Fragmente zweier handschriftlichen Karten von Deutschland aus dem 15. Jahrhundert. Von G. Wolkenhauer. (Aus den Nachrichten der K. Gesellschaft der Wissenschaften zu Göttingen, Philologisch-historische Klasse, 1910.) Size 9½ × 6½, pp. 17–47. *Facsimile Maps.*

Noticed in the Monthly Record for July (*ante*, p. 101).

Greece—Thera. **Gaertringen and Wilski.**

Thera: Untersuchungen, Vermessungen und Ausgrabungen in den Jahren 1895–1902 . . . herausgegeben von F. Frhr. Hiller von Gaertringen. IV. Band. Klimatologische Beobachtungen aus Thera . . . bearbeitet von P. Wilski. Berlin:

G. Reimer, 1902–1909. Size 13 × 10, pp. x. and 202. *Map and Diagrams. Price* 23*s.*

Italy—Abruzzi. *B.S.G. Italiana* IV. **11** (1910): 313–335, 470–484. **Almagià.**
La Marsica. Contributo al Glossario dei nomi territoriali italiani. Del prof. Roberto Almagià.

Italy—Apennines. **Bruzzo.**
B.S.G. Italiana IV. **10** (1909): 1020–1025.
Della distribuzione delle forme di vegetazione sulla montagna bolognese in rapporta con la natura geologica e stabilità dei terreni. Del Prof. G. Bruzzo.

Italy—Earthquake. **Baratta.**
Mario Baratta. La catastrofe sismica Calabro-Messinese (28 Dicembre 1908). (Relazione alla Società Geografica Italiana.) Roma: Società Geografica Italiana, 1910. Size 10 × 7, pp. xvi. and 426. *Maps, Plans, and Illustrations. Presented by the Società Geografica Italiana.*

Italy—Earthquake. *B.S.G. Italiana* IV. **10** (1909): 852–882, 980–1019. **Baratta.**
Il terremoto calabro-siculo del 28 dicembre 1908. Del dott. Mario Baratta. *Facsimile-plan, Illustrations, and Sections.*

Italy—Earthquake. *B.S.G. Italiana* IV. **10** (1909): 1218–1224. **Baratta.**
Alcuni risultati ottenuti dallo studio del terremoto Calabro-Messinese del 28 dicembre 1908. Relazione preliminare del dott. Mario Baratta. *Sketch-map.*

ASIA.

India—Glacial Period. *Geol. Mag.* V. **7** (1910): 193–201. **La Touche.**
Relics of the Great Ice Age in the Plains of Northern India. By T. H. D. La Touche. See September number, p. 356.

India—Himalaya. **Oestreich.**
Land und Leute in Nordwestlichen Himalaya. Vortrag von Prof. Dr. Karl Oestreich. Leipzig, 1909. Size 9 × 6, pp. 10.

India—Kashmir. *Alpine J.* **25** (1910): 39–42. **Neve.**
Mount Kolahoi and its Northern Glacier. By Dr. Ernest F. Neve. *Illustrations.*

Japan—Perry Expedition. **Williams.**
T. Asiatic S. Japan **37** (1910): pp. ix. and 259.
A Journal of the Perry Expedition to Japan (1853–1854). By S. Wells Williams, first interpreter of the expedition. Edited by his son F. W. Williams. *Portraits and Illustrations.*

This is evidently now printed for the first time, though the fact does not appear to be definitely stated.

Japan—Survey. *J. Tokyo G.S.* **21** (1909): 453–467. **Sugiyama.**
Results of the Recent Base Measurements, with a brief account of the land survey in Japan. By S. Sugiyama. *Maps and Diagrams.* [In Japanese.]

Japan—Volcanoes. *T. Asiatic S. Japan* **37** (1909): 87–111. **Mitford.**
The active volcanoes of Japan. By E. Bruce Mitford. *Plan and Illustrations.*

Japan—Yesso—Tarumaé. *J. Tokyo G.S.* **21** (1909): 669–688. **Satō.**
Report on the Eruption of the Tarumaé Volcano. By D. Satō. *Map and Illustrations.* [In Japanese.]

Malay Archipelago—Bali and Lombok. **Wormser.**
Ts. K. Ned. Aardr. Genoots. **25** (1910): 307–320.
De eerste bestijging van de pieken van Lombok en Bali. Door C. W. Wormser. *Illustrations.*

Malay Archipelago—Borneo. *Ts. K. Ned. Aardr. Genoots.* **25** (1910): 263–306. ——
Tochten naar Boven-Boeloengan en de Apo-Kajan. (Zuider- en Ooster-afdeeling van Borneo.) *Sketch-map.*

AFRICA.

Cape Colony—Griqualand West. *T.R.S. South Africa* **1** (1910): 347–361. **Du Toit.**
The Evolution of the River System of Griqualand West. By Alex L. du Toit. *Map and Sketch-map.*

Eritrea. *B.S.G. Italiana* IV. 10 (1909): 1225–1259, 1411–1424. **Bianco.**

Relazione del viaggio de Assab al Dobi e vice-versa. Del cap. Alfredo Bianco. *Sketch-map, Profile, and Illustrations.*

Eritrea—Commerce. **Boselli.**

Istituto Coloniale Italiano, Biblioteca di studi coloniali, No. 1. Nota sul commercio della colonia Eritrea. Di G. E. Boselli. Rome, 1910. Size 9½ × 6½, pp. 22.

French Congo. **Poutrin.**

Notes Ethnographiques sur les populations M'Baka du Congo français. Par le Dr. Poutrin. (Extrait de l'Anthropologie, tom. 21, 1910.) Paris, 1910. Size 10 × 6½, pp. 35–54. *Illustrations. Presented by the Author.*

German East Africa. *M. Deuts. Schutzgebieten* 22 (1909): 198–269. **Heidke.**

Meteorologische Beobachtungen aus Deutsch-Ostafrika. Teil IV. Zusammenstellungen von Monats- und Jahresmitteln aus den Jahren 1905 und 1906 an 28 Beobachtungsstationen. Von Dr. P. Heidke.

German East Africa—Kilimanjaro. **Jaeger.**

M. Deuts. Schutzgebieten 22 (1909): 113–146, 161–197.

Forschungen in den Hochregionen des Kilimandscharo. Von Dr. Fritz Jaeger. *Maps, Illustrations, and Sections.*

German South-West Africa. *M. Deuts. Schutzgebieten* 22 (1909): 1–112. **Seiner.**

Ergebnisse einer Bereisung des Gebiets zwischen Okawango und Sambesi (Caprivi-Zipfel), in den Jahren 1905 und 1906. Von Franz Seiner. *Map and Illustrations.*

Kamerun—Volcanic Eruption. **Mann and Kirchhof.**

M. Deuts. Schutzgebieten 22 (1909): 277–284.

Bericht, betreffend die Ergebnisse einer Untersuchung des Vulkanausbruches im Kamerungebirge in April–Mai 1909. Von Dr. Otto Mann und — Kirchhof. *Sketch-map and Illustrations.*

See note in the July number, p. 103.

NORTH AMERICA.

Alaska. *U.S. Geol. Surv.*, B. 410 (1910): pp. 88. **Maddren.**

The Innoko Gold-Placer District, Alaska. With accounts of the Central Kuskokwim Valley and the Ruby Creek and Gold Hill Placers. By A. G. Maddren. *Maps.*

Alaska—Glaciation. *J. Geol.* 18 (1910): 33–57. **Capps.**

Glaciation of the north side of the Wrangell Mountains, Alaska. By Stephen R. Capps. *Map, Sections, and Illustrations.*

Alaska—Hubbard Glacier. *Popular Sc. Monthly* 76 (1910): 293–305. **Martin.**

The Hubbard Glacier, Alaska. By Prof. Lawrence Martin. *Sketch-maps and Illustrations.*

Alaska—Magnetism. **Faris.**

Department of Commerce and Labor. Coast and Geodetic Survey. Terrestrial Magnetism. Distribution of the Magnetic Declination in Alaska and Adjacent Regions for 1910. By R. L. Faris. Appendix No. 4. Report for 1909. Washington, 1910. Size 11½ × 8, pp. 153–179. *Map and Diagrams.*

Canada—Ontario. **Collins.**

Canada. Department of Mines. Geological Survey. A Geological reconnaissance of the region traversed by the National Transcontinental Railway between Lake Nipigon and Clay Lake, Ontario. By W. H. Collins. Ottawa, 1909. Size 9½ × 6½, pp. 68. *Maps, Illustrations, and Diagram.*

Includes general information on the district.

North America—Cordillera. *B. American G.S.* 42 (1910): 161–179. **Joerg.**

The tectonic lines of the northern part of the North American cordillera. By W. Joerg. *Map.*

Based mainly on the recently published final volume of Suess's great work.

United States—Arizona. *Naturw. Wochenschrift* 24 (1909): 801–810. **Meinecke.**

Der Meteorkrater von Canyon Diablo in Arizona und seine Bedeutung für die Entstehung der Mondkrater. Von Franz Meinecke. *Illustrations and Sections.*

CENTRAL AND SOUTH AMERICA.

Bolivia. **Calderon.**

Economic Conditions of Bolivia. By Ignacio Calderon. A lecture delivered before the special class in Commerce at Harvard University, March 17, 1910. [Washington, 1910.] Size 9 × 6, pp. 24. *Map.*

Bolivia—Communications. **Bowman.**

B. American G.S. **42** (1910): 22–37, 92–104, 180–192.

Trade routes in the economic geography of Bolivia. By Isaiah Bowman. *Sketch-maps and Illustrations. Also separate copy.* (Size 9½ × 6.)

Brazil—Ceara. *Ann. G.* **18** (1909): 46–62. **Denis.**

Le Ceara. Par Pierre Denis.

Chile—Juan Fernandez. **Skottsberg.**

Vegetationsbilder (Karsten and Schenck) **8** (1910): Plates 7–12.

Vegetationsbilder von den Juan Fernandez Inseln. Von Carl Skottsberg. *Illustrations.*

Cuba—Sagua la Grande. **Alcover.**

La villa de Sagua la Grande (Republica de Cuba). Bosquejo critigo-descriptivo. Por Antonio Miguel Alcover (Publicado en La Revista "Cuba y America.") Havana, 1909. Size 7½ × 5½), pp. 48. *Illustrations. Presented by the Author.*

Haiti. *B.S.R.G. Anvers* **33** (1909): 711–730. **Castiau.**

La République d'Haiti. Histoire, Richesses naturelles, Villes, Habitants. Voies de communication. Par Marcel Castiau.

Peru.

Peru. Report for the years 1908-09 on the Trade, Commerce, and Finance of Peru. (Diplomatic and Consular Reports, Annual No. 4423, 1910.) Size 9½ × 6, pp. 62.

Includes a useful sketch of the railway system of Peru.

Peru—Geology. *Smithsonian Rept.* 1908 (1909): 385–430. **Adams.**

An outline review of the geology of Peru. By George I. Adams. *Maps, Diagrams, and Sections.*

Deals also with the physical geography.

South America—Rainfall. *Quart. J.R. Met. S.* **36** (1910): 49–59. **Reed.**

South American Rainfall Types. By William Gardner Reed. *Sketch-map and Diagrams.*

Venezuela—Phytogeography. **Johnston.**

P. Boston S. Natural Hist. **34** (1909): 163–312.

Contributions from the Gray Herbarium of Harvard University. New Series, No. xxxvii. Flora of the Islands of Margarita and Coche, Venezuela. By John Robert Johnston. *Sketch-maps and Illustrations.*

AUSTRALASIA AND PACIFIC ISLANDS.

New Guinea—British—Ethnology. **Seligmann.**

J.R. Anthropological I. **39** (1909): 246–275, 314–333.

A Classification of the Natives of British New Guinea. By Dr. C. G. Seligmann. *Sketch-maps and Illustrations.*

New Guinea—Dutch. *Ts. K. Ned. Aardr. Genoots.* **27** (1910); 346–353. **Rühl.**

Nieuwe verkenning van de Tami-rivier, Noord Nieuw Guinea. Door C. Rühl.

New Guinea—Dutch. *Ts. K. Ned. Aardr. Genoots.* **27** (1910): 323–328. **Weel.**

Verkenning van rivieren tusschen Oost-baai en Digoel-rivier. (Zuid Nieuw-Guinea.) Door K. M. van Weel. *Sketch-map.*

New Guinea—Dutch. *Ts. K. Ned. Aardr. Genoots.* **27** (1910): 353–357. **[Rambonnet.]**

Het westelijk deel der Humboldt-Baai, Noord Nieuw-Guinea. [Door F. L. Rambonnet.] *Sketch-map.*

New Guinea—German. *Globus* **97** (1910): 285–286. **Reche.**

Eine Bereisung des Kaiserin-Augusta-Flusses (Neuguinea). Von Dr. O. Reche. *Map.*

A short account of the visit of Dr. Fülleborn's expedition in the *Peiho*, mainly with a view to ethnological work. This took place after the ascent of the river alluded to in vol. **34**, p. 458, had been made.

New South Wales—Federal Capital.

New South Wales: Legislative Assembly. Federal Capital Site. (Papers and plans received from the Prime Minister of the Commonwealth respecting the Yass-Canberra proposed Federal Territory.) [Sydney, 1909.] Size 13 × 8½, pp. 28. *Maps. Presented by the Agent-General for New South Wales.*

See article and maps in the March number, p. 318.

Solomon Islands. *Putnam Anniversary Volume* (1909): 521–544. **Dorsey.**

A visit to the German Solomon islands. By George A. Dorsey.

Western Australia—Zoogeography. *P. Zoolog. S.* (1909): 803–848. **Shortridge.**

An Account of the Geographical Distribution of the Marsupials and Monotremes of South-West Australia, having special reference to the specimens collected during the Balston Expedition of 1904-1907. By G. C. Shortridge. *Sketch-maps.*

POLAR REGIONS.

Arctic—Peary Expedition. **Moore.**

Peary's discovery of the North Pole. Speech of Hon. J. Hampton Moore, in the House of Representatives, March 22, 1910. Washington, 1910. Size 9 × 6, pp. 36.

Greenland—Eskimos. **Steensby.**

Contributions to the Ethnology and Anthropogeography of the Polar Eskimos. By H. P. Steensby. (Reprinted from *Meddelelser om Grönland*, vol. **34.**) Copenhagen: Bianco Luno, 1910. Size 9 × 6, pp. 255–406. *Sketch-maps and Illustrations. Presented by the Author.*

Greenland—Phytogeography. **Rikli.**

Vegetationsbilder (*Karsten & Schenck*) **7** (1910): Plates 43–48.

Vegetationsbilder aus Dänisch-Westgrönland. Von M. Rikli. *Illustrations.*

Polar Travel. *B.S.G. Italiana* **IV. 11** (1910): 178–211. **Faustini.**

I viaggi in slitta nelle regioni polari. Di Arnaldo Faustini.

MATHEMATICAL GEOGRAPHY.

Cartography. *G. Z.* **16** (1910): 12–28, 73–82. **Hettner.**

Die Eigenschaften und Methoden der kartographischen Darstellung. Von Alfred Hettner.

Cartography—Models. *B.S.G. Philadelphia* **8** (1910): 67–71. **Martin.**

The University of Wisconsin Models. By Prof. Lawrence Martin. *Illustrations.*

Surveying—Photographic. **Klingatsch.**

Sitzb. K.A.W. Wien, Abt. II*a*. **118** (1909): 485–509.

Zur photographischen Ortsbestimmung. Von Adolf Klingatsch. *Diagram.*

Surveying—Tacheometry. *Cairo Sc. J.* **4** (1910): 45–50. **Ball.**

Long Distance Tacheometry. Tacheometry with an Ordinary Theodolite. By Dr. John Ball.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Geomorphology—Denudation. **Günther.**

Sitzb. K. Bayerischen A. W., Math.-phys. Kl. (1909): 8 Abh., pp. 18.

Untersuchungen über Wackelsteine und damit Zusammenhängende Denudationserscheinungen. Von Siegmund Günther. *Illustrations.*

Geomorphology—Dunes. *Ts. K. Ned. Aardr. Genoots.* **27** (1910): 205–217. **Balen.**

Duinvlakten en windkuilen. Door C. L. van Balen.

Geomorphology—Rivers. *Ann. G.* **18** (1909): 311–327. **Vacher.**

Rivières à méandres encaissés et terrains à méandres. Par Antoine Vacher. *Illustrations.*

Magnetism. *Abh. k. Preuss. Met. I.* **3** (1909): No. 3, pp. 62. **Hellmann.**

Magnetische Kartographie in historisch-kritischer Darstellung. Von G. Hellmann. *Sketch-maps.*

A sketch of the evolution of the cartography of terrestrial magnetism.

Meteorology—Refraction. *Ann. Hydrographie* **37** (1909): 306–324. **Brehmer.**

Beitrag zur atmosphärischen Refraktion über Wasserflächen. Von Kurt Brehmer. *Diagrams.*

Meteorology—Winds. *American J. Sc.* **29** (1910): 277–292. **Bigelow.**
Studies on the General Circulation of the Earth's Atmosphere. By Frank H. Bigelow. *Diagrams.*

Meteorology—Winds. *Quart. J. R. Met. S.* **36** (1910): 25–38. **Shaw.**
The Variations of Currents of Air indicated by Simultaneous Records of the Direction and Velocity of the Wind. By Dr. William Napier Shaw. *Diagrams.*

Mountain Formation. *Sitzb. k. Preuss. A.W.* (1909): 87–104. **Tornquist.**
Die Annahme der submarinen Erhebung des Alpenzuges und über Versuche, Vorstellungen über submarine Gebirgsbewegung zu erlangen. Von Prof. Dr. A. Tornquist.

Oceanography—Baltic. **Gehrke.**
Beitrag zur Hydrographie des Finnischen Meerbusens. Von Johan Gehrke. (Finnländische Hydrographisch-Biologische Untersuchungen, Nr. 3.) Helsingfors, 1909. Size 12½ × 9½, pp. 40. *Diagrams.*
See notice of the two previous parts, in February number, 1910, p. 180.

Oceanography—Pacific. *Z. Ges. E. Berlin* (1910): 92–97. **Schott.**
Die Wärmeverteilung in den Tiefen des Stillen Ozeans. Von Prof. Gerhard Schott. *Charts.*

Oceanography—Pacific. *Ann. Hydrographie* **38** (1910): 2–25. **Schott and Schu.**
Die Wärmeverteilung in den Tiefen des Stillen Ozeans. Von Prof. Dr. Gerhard Schott and Fritz Schu. *Maps, Sections, and Diagrams.*

Oceanography—Sea-water. **Ruppin.**
Die Alkalinität des Meerwassers. Meerwasser, Kohlensäure, Kohlensäurer Kalk, ein System aus 3 Bestandteilen nach der Phasenregel. Von Dr. E. Ruppin. (Arbeiten der Deutschen Wissenschaftlichen Kommission für die Internationale Meeresforschung; A. Aus dem Laboratorium für internationale Meeresforschung in Kiel. Hydrographische Abteilung, No. 7.) Kiel, 1909. Size 12½ × 10½, pp. 277–302. *Maps.*

Oceanography—Tidal phenomena. **Pettersson.**
Conseil Exploration la Mer, Publications de Circonstance, No. 47 (1909): pp. 22.
Gezeitenänliche Bewegungen des Tiefenwassers. Von Dr. O. Pettersson. *Diagr.*

Seismology. **Agamennone.**
Atti R.A. Lincei V. Rendiconti Sc. fisiche, etc., **18** (1909): 1 Sem., 393–398.
Alcune considerazioni sul meccanismo di propogazione delle onde sismiche. Di G. Agamennone.

Terrestrial Magnetism. *B. American G.S.* **42** (1910): 1–8. **Littlehales.**
The South Magnetic Pole. The Magnetic Inclination and Declination in the Approaches to it, as reduced from Observations made in 1840 by the United States Expedition commanded by Lieut. Charles Wilkes. By G. W. Littlehales.

Volcanic Phenomena. *Science* **24** (1906): 161–166. **Thomson.**
The Nature and Origin of Volcanic Heat. By Dr. Elihu Thomson.

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Anthropogeography. *B.S.G. Italiana* IV. **11** (1910): 122–134. **Issel.**
La rotazione terrestre è per l'uomo fattore precipuo della distribuzione geografica. Del prof. Arturo Issel.

Anthropology. **[Putnam.]**
Putnam Anniversary Volume. Anthropological essays presented to Frederic Ward Putnam in honour of his seventieth birthday, April 16, 1909, by his friends and associates. New York: G. E. Stechert & Co., 1909. Size 11½ × 9, pp. viii. and 628. *Portrait and Illustrations. Presented by Prof. F. W. Putnam.*

Climate and Man. *Popular Sc. Monthly* **76** (1910): 246–268. **Ward.**
Climate in some of its Relations to Man. By Prof. Robert De C. Ward.

Commercial—Waterways. *B.S.G. Italiana* IV. **10** (1909): 1367–1401. **Daverio.**
La navigazione interna. Di P. Piola Daverio. *Maps, Plans, and Illustrations.*
Illustrated by examples from various European countries.

Historical—Girault. *B.G. hist. et descriptive* (1909): 182–199. **Pawlowski.**
Le cosmographe Haut-Marnais Simon Girault (XIV^e^ siècle). Par Auguste Pawlowski.

Historical—Pillars of Hercules. **Kittredge.**
Putnam Anniversary Volume (1909): 545–566.
The Pillars of Hercules and Chaucer's "Trophee." By G. L. Kittredge.
Noticed in the Monthly Record, July number, p. 107.

Historical—Verazzano. *B.S.G. Italiana* IV. 10 (1909): 1274–1323. **Bacchiani.**
Giovanni da Verazzano e le sue scoperte nell' America settentrionale (1524) secondo l'inedito codice sincrono Cèllere di Roma. Studi di Alessandro Bacchiani. *Facsimile Map and Illustrations.*
See article in the April number, p. 428.

History of Cartography. *B.S.G. Italiana*, IV. 11 (1910): 269–279. **Revelli.**
Una "rosa dei venti" del secolo IX. Del Prof. Paolo Revelli. *Facsimile.*

GENERAL.

Sleeping sickness.
Sleeping Sickness: How to avoid Infection. With an account of *Glossina Palpalis* and Illustrations of this and other Biting Flies. For the use of Travellers and Residents in Tropical Africa. London: Sleeping Sickness Bureau, 1910. Size 7½ × 5, pp. 16. *Illustrations. Presented by the Sleeping Sickness Bureau.*

NEW MAPS.

By E. A. REEVES, *Map Curator*, R.G.S.

EUROPE.

British Isles—England and Wales. **Ordnance Survey.**
Sheets published by the Director-General of the Ordnance Survey, Southampton, from August 1 to 31, 1910.

4 miles to 1 inch:—
County Diagram, showing civil parishes, with a table of their areas. West Riding of Yorkshire. *Price* 6*d.*

1-inch map (third edition) (engraved):—
Outline, 179. *Price* 1*s.*
Hills in black or brown, 339, 349. *Price* 1*s. each.*
Large-sheet series, printed in colours, and folded in cover or flat in sheets, 41 and 57. *Price, on paper,* 1*s.* 6*d.*; *on linen,* 2*s.*; *mounted in sections,* 2*s.* 6*d.*

6-inch—County maps, with contours in blue:—
Cheshire, 1 sheet. **Hampshire,** 7 sheets. **Kent,** 1 sheet. **Lancashire,** 4 sheets. **Sussex,** 6 sheets. **Yorkshire,** 16 sheets. *Price* 1*s. each.*

1:2500 Scale—County maps:—
Cheshire, 17 sheets. **Hampshire,** 33 sheets. **Lancashire,** 20 sheets. **Sussex,** 33 sheets. **Yorkshire,** 47 sheets. *Price* 3*s. each.*
(*E. Stanford, London Agent.*)

Spain. **Fribourg.**
Die Herdenwanderungen in Spanien nach A. Fribourg. Scale 1:3,700,000 or 1 inch to 58·4 stat. miles. *Petermanns Mitteilungen,* Jahrgang, 1910, II., Tafel 17. Gotha: Justus Perthes, 1910. *Presented by the Publisher.*

ASIA.

China. **Weiss.**
Rundreise des Kaiserlich Deutschen Konsulatsverwesers von Chengtu-Chunking Weiss in Sze-chuan (West China). (Ta-chien-lu—Tailing—Dang-ling pass—Romi-Changu—Tapao-shan pass—Ta-chien-lu.) Scale 1:500,000 or 1 inch to

7·8 stat. miles. *Petermanns Mitteilungen*, Jahrgang, 1910, II., Tafel 12. Gotha: Justus Perthes, 1910. *Presented by the Publisher.*

The portion of the route followed by Consul Weiss, through the little-known region shown on this map extends from 30° to 31° 20′ N. lat. and from 100° 20′ to 102° 15′ E. long. A general map of Sechuan, showing the whole of the route from Cheng-tu, is given as an inset. The map, with several photographs, accompanies an account of the journey given in the August number of *Petermanns Geograph. Mitteilungen.*

AFRICA.

Africa. **Geographical Section, General Staff.**

Map of Africa. Compiled in the Geographical Section, General Staff. Scale 1 : 250,000 or 1 inch to 3·9 stat. miles. Sheets (Sierra Leone): 59-M, Falaba; 59-N, Tembikunda; 59-T, Kissi; 71-A, Bandajuma; 71-B, Gola. London: Edward Stanford, 1909. *Price* 1*s.* 6*d. net each sheet.*

Africa. **Service Cartographique du Gouvernement Général de l'Algérie.**

Map of the French possessions in Africa. [In Arabic.] Scale 1 : 17,000,000 or 1 inch to 268·3 stat. miles. Algiers: Adolphe Jourdan, 1910. *Presented by M. R. de Flotte de Roquevaire, Chef du Service Cartographique, Gouvernement Général de l'Algérie.*

Africa. **Sleeping Sickness Bureau.**

Die Verbreitung der Schlafkrankheit und der Tsetsefliegen im tropischen Afrika. Nach den Karten des Sleeping Sickness Bureau vom Oktober, 1909. Scale 1 : 25,000,000 or 1 inch to 394·5 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1910, II., Tafel 11. Gotha: Justus Perthes, 1910. *Presented by the Publisher.*

An outline map of tropical Africa, taken from Stieler's Hand Atlas, and showing, by various colours and symbols, the distribution of sleeping sickness and tsetse fly. The map is prepared from those of the Sleeping Sickness Bureau, published in October last.

Algeria. **Service Cartographique du Gouvernement Général de l'Algérie.**

Carte de l'Algérie. Dressée par ordre de M. Jonnart, Gouverneur-Général de l'Algérie, au Service Cartographique du Gouvernement Général de l'Algérie. Scale 1 : 200,000 or 1 inch to 3·2 stat. miles. Sheets: 13, Boghari; 14, Bou-Saada. Algiers: Adolphe Jourdan, [1910]. *Presented by M. R. de Flotte de Roquevaire, Chef du Service Cartographique, Gouvernement Général de l'Algérie.*

Algerie. **Service Cartographique du Gouvernement General de l'Algérie.**

Cartes Scolaires: Algér; Constantine; Oran. Dressée par ordre de M. C. Jonnart, Gouverneur-Général. Scale 1 : 400,000 or 1 inch to 6·3 stat. miles. Algiers: Adolphe Jourdan, [1910]. *Presented by M. R. de Flotte de Roquevaire, Chef du Service Cartographique, Gouvernement Général de l'Algérie.*

A set of coloured maps without hill-shading, showing the distribution and different classes of schools throughout these provinces of Algeria. A considerable amount of information is given on all matters connected with educational establishments by symbols and colours, in addition to which all means of communication are clearly laid down.

Egypt. **Survey Department, Giza.**

Topographical map of Egypt. Scale 1 : 10,000 or 6·3 inches to 1 stat. mile. Sheets: s.w. 131–8, 131–9, 132–8, 132–9, 133–8, 133–9, Mudiria Assiut. Giza: Survey Department, 1910. *Presented by the Director-General, Survey Department, Giza.*

Tunis. **Hübner.**

Das südtunesische Grenzland. Uebersichtskarte zum französisch-turkischen Grenzstreit. [Von Oberstleutn. z. D. Max Hübner.] Scale 1 : 2,000,000 or 1 inch to 31·5 stat. miles. *Petermanns Mitteilungen*, Jahrgang, 1910, II., Tafel 19. Gotha: Justus Perthes, 1910. *Presented by the Publisher.*

AMERICA.

Brazil. **Arp.**

Mappa do Brazil baseado no Mappa da America do Sul de Stieler. 2 sheets. Scale 1 : 4,500,000 or 1 inch to 71·02 stat. miles. Rio de Janeiro: Arp & Cia., [1910].

As stated in the title, this highly-coloured map is based upon and enlarged from the six-sheet map of South America on the scale of 7,500,000 given in Stieler's hand-

atlas. However, it is a much rougher production, and in parts not so clear as might be desired. In addition to Brazil, the map includes Bolivia, Paraguay, Uruguay, and portions of other adjacent countries. In some respects the boundaries are not up to date.

Canada. **Department of the Interior, Ottawa.**

Rocky mountains between Latitude 51° and 53° 10′. Scale 1 : 253,440 or 1 inch to 4 stat. miles. 2 sheets. Ottawa : Department of the Interior, 1910. *Presented by the Department of the Interior, Ottawa.*

This sheet shows the Canadian-Pacific railway from Calgary through the Kicking Horse pass to below Golden and the interesting region of the Rocky mountains immediately to the north. The area included lies between lat. 51°–53° 10′ N. and long. 114°–117° 5′ W. The relief is indicated by contours in brown at intervals of 500 feet, and where these are approximate only the lines are broken. Many heights are given in figures. Rivers are in blue, but it would have been an improvement if their names had also been in this colour, and if the lakes had been shown by a blue tint instead of in outline only. However, it is a useful map, prepared from the latest information.

Canada. **Department of Militia and Defence, Ottawa.**

Topographic map of Canada. Scale 1 : 63,360 or 1 inch to 1 stat. mile. Sheet 24, Chateauguay, Quebec. Ottawa : Department of Militia and Defence ; London : Geographical Section, General Staff, 1909. *Presented by the Director of Military Operations.*

United States. **U.S. Geological Survey.**

United States Geological Survey. Map of the United States, showing areas covered by topographical surveys and the scale employed for each area. Scale 1 : 14,000,000 or 1 inch to 220·9 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1910, II., Tafel 18. Gotha : Justus Perthes, 1910. *Presented by the Publisher.*

PACIFIC OCEAN.

New Guinea. **Sieberg.**

Versuch einer seismotektonischen Skizze des Schutzgebietes Deutsch-Neu-Guinea (Kaiser Wilhelms-Land und Bismarck-Archipel). Entworfen von A. Sieberg. Scale 1 : 10,000,000 or 1 inch to 157·8 stat. miles. *Petermanns Mitteilungen*, Jahrgang 1910, II., Tafel 15. Gotha : Justus Perthes, 1910. *Presented by the Publisher.*

CHARTS.

Admiralty Charts. **Hydrographic Department, Admiralty.**

Charts and Plans published by the Hydrographic Department, Admiralty, during July, 1910. *Presented by the Hydrographer, Admiralty.*

New Charts—No. 838, Scotland, west coast, Arran island : Brodick bay, 2*s*. 2200, Newfoundland, west coast : Port Saunders, Keppel harbour, and Hawke bay, 3*s*. 2229, South America, Brazil, and Peru, river Amazon : Gurupa to Iquitos, 3*s*. 1331, South America, east coast : Approaches to Bahia Blanca (Port Belgrano), 3*s*. 3755, South America, east coast : Bahia Blanca, inner port. Plans : Puerto Galvan, Puerto Ingeniero White, 3*s*. 820, Africa, north-west coast : Cape Fédala to Cape Blanco (north). Plans : Fédala, Mazighan, Casablanca (Dar el Beida), 3*s*. 3756, Eastern archipelago : Linta and Molo straits, 3*s*. 3585, China, north-east coast : Approaches to the Wusung river, 3*s*. **New Plans and Plans added**—No. 1622, Ports in the Philippine islands. New Plan : Mauban bay, 3*s*. **New Editions**—No. 2162, Scotland, north coast : Pentland firth, 2*s*. 2581, Orkney islands : Scapa flow and approaches, southern sheet, 3*s*. 1772, Ireland, east coast : Approaches to Wexford harbour, 3*s*. 6*d*. 3043, Germany : Gienner fiord, 2*s*. 144, Gibraltar, 2*s*. 2207, Black sea, Danube river : Sulina mouth, 2*s*. 643, Africa, south-east coast : Port Natal, 3*s*. 2862, Baluchistan : Jashk bay, 2*s*. 961, Borneo : Basilan strait, 3*s*. 1601, China, north-east coast : Wusung river, 4*s*. 2973, Australia, south coast : Mary Ann haven, 2*s*.

Atlantic, North. **U.S. Hydrographic Office.**

Pilot chart of the North Atlantic Ocean, August, 1910. Washington : U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

Atlantic, North. **U.S. Weather Bureau.**

Meteorological chart of the North Atlantic Ocean, October, 1910. Washington: Department of Agriculture, U.S. Weather Bureau, 1910. *Presented by the U.S. Weather Bureau.*

Atlantic, North, and Mediterranean. **Meteorological Office.**

Monthly meteorological charts of the North Atlantic and Mediterranean, September, 1910. London: Meteorological Office, 1910. *Price 6d. each. Presented by the Meteorological Office.*

Indian Ocean. **Meteorological Office.**

Monthly meteorological charts of the Indian Ocean, September, 1910. London: Meteorological Office, 1910. *Price 6d. each. Presented by the Meteorological Office.*

Indian Ocean. **U.S. Hydrographic Office.**

Pilot chart of the Indian Ocean, September, October, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

Norway. **Norges Geografiske Opmaaling.**

Kystkarter. Nr. 52, Högbraken; 70, Röst til Værøy; 219, Nordmörefjordene. Christiania: Norges Geografiske Opmaaling, 1910. *Presented by the Norwegian Geographical Institute.*

Pacific, North. **U.S. Hydrographic Office.**

Pilot chart of the North Pacific Ocean. October, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

Pacific, North. **U.S. Weather Bureau.**

Meteorological chart of the North Pacific Ocean, October, 1910. Washington: Department of Agriculture, U.S. Weather Bureau. 1910. *Presented by the U.S. Weather Bureau.*

Pacific, South. **U.S. Hydrographic Office.**

Pilot chart of the South Pacific Ocean, September, October, and November, 1910. Washington: U.S. Hydrographic Office, 1910. *Presented by the U.S. Hydrographic Office.*

PHOTOGRAPHS.

General **Guillemard and Others.**

357 photographs of famous waterfalls of the world. *Presented by F. H. H. Guillemard, Esq., M.A., M.D.*

These valuable and interesting photographs and photographic reproductions form an important addition to the Map Room collection. During many years Dr. Guillemard and his brother were collecting them from all parts of the world, and while many were taken by themselves during their extensive travels, a large number were given to them or purchased at various times. There is probably nowhere to be found another so complete series as this, and many of the views are most striking and beautiful. Although of different sizes, the photographs will be all mounted on cards of one size, and placed in a portfolio, care being taken in their arrangement and description.

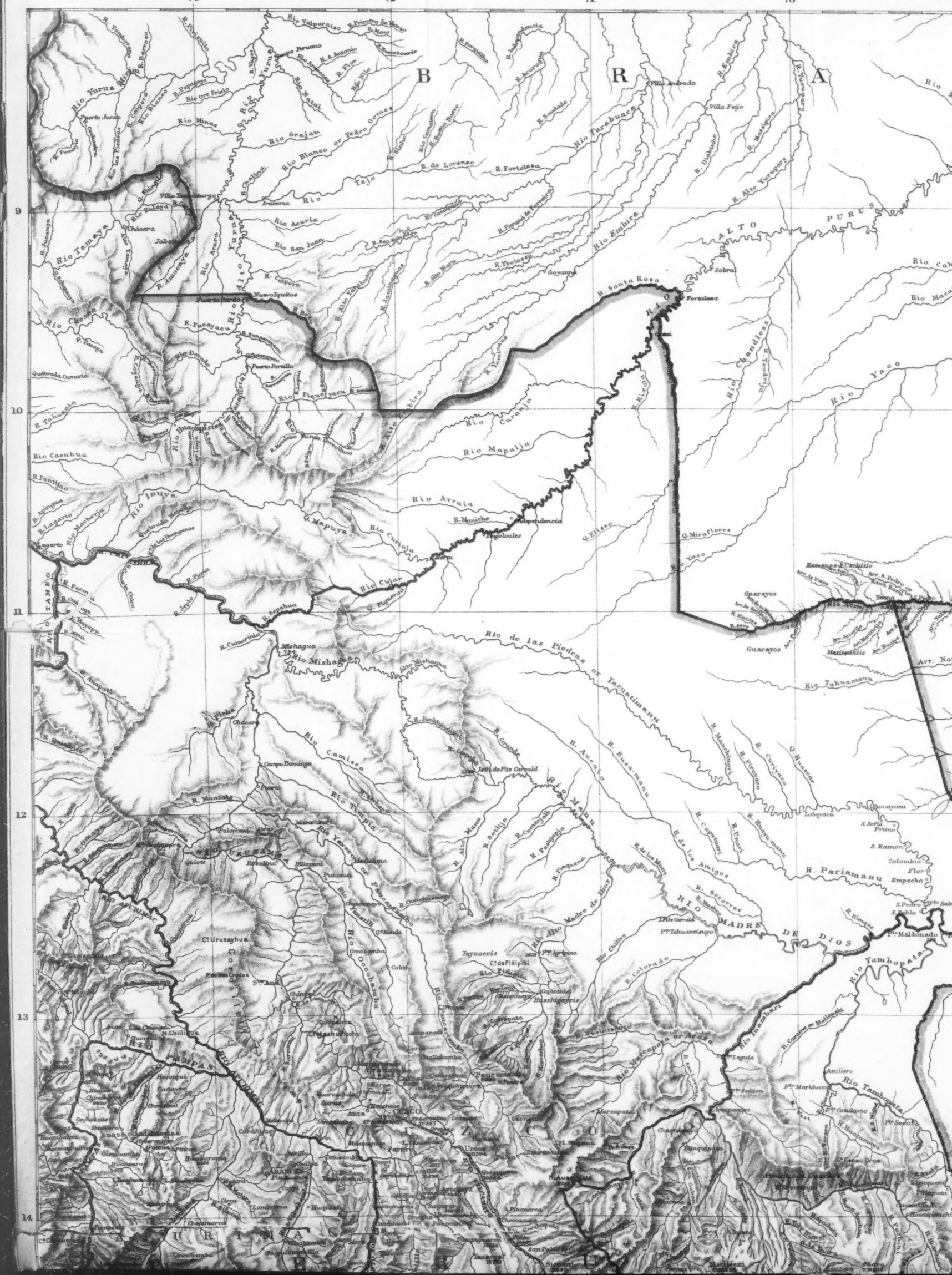
Europe. *Austria*:—(1) Golling; (2 and 3) Ober Krimmler; (4) Traun; (5) Stuiben; (6) Barin. *British Isles*:—(7) Aira Force; (8) Barrow Force; (9) Colwith Force; (10) Stock Gill Force; (11 and 12) Scale Force; (13) Upper Rydal; (14) Aysgarth Force; (15) High Force; (16) Scaleber Force; (17) Waterfall in Bolton woods; (18) Llanberis; (19) Pistyll Cain; (20) Rhayadr Mawr; (21 and 22) Swallow; (23) Upper falls of the Bruar; (24) Middle falls of the Bruar; (25–27) Corra Linn; (28 and 29) Bonnington Linn; (30) Foyers; (31) Lower Foyers; (32) Upper Moness; (33) Lower Moness; (34) Tummel; (35) Fall in Dunrobin Glen; (36) The Grey Mare's Tail; (37) Victoria; (38) Inversnaid; (39) Alt-Girnaig; (40) Hermitage; (41) Glencar; (42) Fall in the Devil's Glen; (43) Muckross; (44) O'Sullivan; (45) Powerscourt; (46) Torc. *Finland*:—(51-53) Imatra. *France*:—(47) Cascade in Bois de Boulogne, Paris; (48) Le Saut du Loup; (49) Cirque; (50) Larassec. *Germany*:—(54) Waterfall in the Black Forest. *Iceland*:—(55 and 56) Gullfos: (57) Waterfall in Almannazza. *Italy*:—(58) Terni; (59) Bernini; (60) Cascatelle; (61) Grande Cascata; (62) Tosa. *Norway*:—(63) Ædna near Odde; (64) Boknedalsfos; (65) Dönefos; (66) Döntefos; (67) Eidsfos; (68–70) Espelandsfos; (71 and 72) Feigumsfos; (73) Fiskumfos; (74) Furebergsfos; (75) Galdefos; (76) Goellefos; (77) Hallandsfos;

(78) Hildalsfos; (79 and 80) Hjorpefos; (81) Huldrefos (82 and 83) Hyllandsfos; (84) Kilefos; (85) Falls between Lillehammer and Fossegaard; (86 and 87) Little Lerfos; (88) Maarkafos; (89 and 90) Mardalsfos; (91) Mongefos; (92) Ofsthusfos; (93–95) Rembesdalsfos; (96 and 97) Rjukanfos; (98) Rodelven; (99) Roikjafos; (100) Sarpsfos; (101) Sarvfos; (102 and 103) Sivlefos; (104 and 105) Skjaeggedalsfos; (106) Skjervefos; (107) Skjordalsfos; (108 and 109) Skorvefos; (110) Skrikjofos; (111 and 112) Skykjefos; (113) Skykkjedalsfos; (114 and 115) Sonselifos; (116 and 117) Stalheimsfos; (118 and 119) Store Lerfos; (120) Storsaeterfos; (121) Syv Fald; (122) Tinnfos; (123) Tussefos; (124 and 125) Tyssestrengene; (126) Waterfall in Valders; (127) Vasendenfos; (128) Vaermofos; (129) Vidalsfos; (130) Vigelandsfos; (131 and 132) Voringfos. *Spain*:—(143) Cola de Caballo; (144) Caprichosa; (145) Del Vado. *Sweden*:—(133) Ristanfors; (134) Storbafallet; (135) Tännfors; (136) Nedre Handälsfors; (137 and 142) Gullöfallet; (138) Helvetesfallet; (139 and (140) Toppöfallet; (141) Vattenfallen. *Switzerland*:—(146) Bérard; (147) Gorges de Trient; (148) Handegg; (149) Dailley; (150) Pissevache at Vernayaz; (151) Schaffhausen; (152) Rosenlaui; (153 and 154) Giessbach; (155 and 156) Reichenbach; (157 and 158) Upper Reichenbach; (159) Lower Reichenbach; (160) Schreienbach; (161) Schmadribach; (162) Staubback; (163) Stäuberbach. **Asia.**—*Asiatic Turkey*:—(164) Incrustating waterfall at Hierapolis; (165) N. Barada (Abana). *Ceylon*:—(166 and 167) Badulu; (168) Uma Oya; (169–172) Ramboda; (173) Kirkoswald; (174) Maskeliya valley; (175) Maturata; (176) St. Clair; (177) Devon; (178) Nahavilla. *India*:—(179) Batta; (180) Nerbudda at Bheraghat; (181) Bishop's; (182) Yenna; (183) Avalanche; (184) Benhope; (185) Upper Kolakambe; (186) Law; (187 and 188) Falls near Utakamand; (189 and 190) Upper Pykara; (191) Lower Pykara; (192) Rapids on the Pykara; (193) Sentinal; (194–196) Bar Chaki, near Seringapatam; (197) Gangan Chaki, near Seringapatam; (198–203) Gairsoppa; *Japan*:—(204) Tojinoki; (205) Sugaruga-Taki; (206) Nachi. *Malay Peninsula and Archipelago*:—(207) Fall at Penang; (208) Tondano Celebes; (209) Tjoervek Tjimahi, Java; (210) Sampalit, Philippine Islands. **Africa.** *Basutoland*:—(211 and 212) Malutsunyane; (213) Ketane. *Natal*:—(214) Tugela; (215 and 216) Karkloof; (217 and 218) Umgeni. *Rhodesia*:—(219–233) Victoria. *Transvaal*:—(234 and 235) Tolo **Azima. America.** *Canada*:—(236 and 237) Chaudière; (238) Calumet; (239) Kakabeka, Kaministikwia river; (240–245) Niagara; (246) Grand Metis; (247) Rideau; (248) Rivière du Loup; (249) Shawenegan; (250) Yo-ho; (251) Takakkaw; (252) Muskrat, Labrador; (253) Tracking round the Minnipi, Labrador; (254–257) Grand Falls, Labrador; (258) Grand Falls of the Nepisiguit. *United States*:—(259) Lake Creek; (260) Mooney; (261) Bridal Veil, Yosemite; (262 and 263) Yosemite; (264) Upper Yosemite; (265) Lower Yosemite; (266 and 267) Vernal; (268) Virgin's Tears, Yosemite; (269) Gardner; (270) Borin's; (271) Cheyenne; (272 and 273) Falls on Camp Creek; (274) Red Rock; (275) Argenta; (276) Cascades in Cunningham Gulch; (277 and 278) Falls at foot of Round Top mountain; (279) Lower Falls on Lake Fork; (280) Arched Falls, Mount Blackmore; (281) Cascades from Mount Blackmore; (282) Shoshone; (283) Minnehaha; (284) Madison; (285) Cascades near Ogden; (286 and 287) Multnomah; (288–298) Yellowstone; *Mexico*:—(299–302) Juanacatlan. *Argentine and Brazil*:—(304–308) Iguazú. *British Guiana*:—(309–311) Kaieteur; (312) Pataro river above Kaieteur Falls. *Chile*:—(313) Falls of the Laja. *Colombia*:—(314) Tequendama. **Australasia.** *New South Wales*:—(315) Little Weatherboard; (316) Campbell; (317) Upper Campbell; (318) Govett's Leap. *Queensland*:—(319) Fall on Bloomfield river; (320) Wodall. *Victoria*:—(321) Marysville; (322) Wannon; (323 and 324) Splitters; (325 and 326) Erskine river waterfall. *Tasmania*:—(327–329) Silver. *New Zealand*:—(330) Waitakeri; (331) Waitangi; (332 and 333) Bowen; (334) Bealey river; (335) Sutherland; (336) Alfred; (337) Waimakariri; (338) Punch Bowl; (339) Snake; (340) Muka. **Madeira.**—(341) "The Twenty-five Springs"; (342) Ra baçal; (343) Da Silveira; (344) Coast view, Santa Anna; (345) Fall at São Vicente; (346) St. Luzia. **Mauritius**:—(347 and 348) Tamarin; (349) Réduit; (350) Grand River South East; (351) Diamauv; (352) River du Poste; (353 and 354) Falls in Mauritius. **Hawaiian Islands**:—(355) Fall in Kauai; (356) Rainbow; (357) Fall near Hilo.

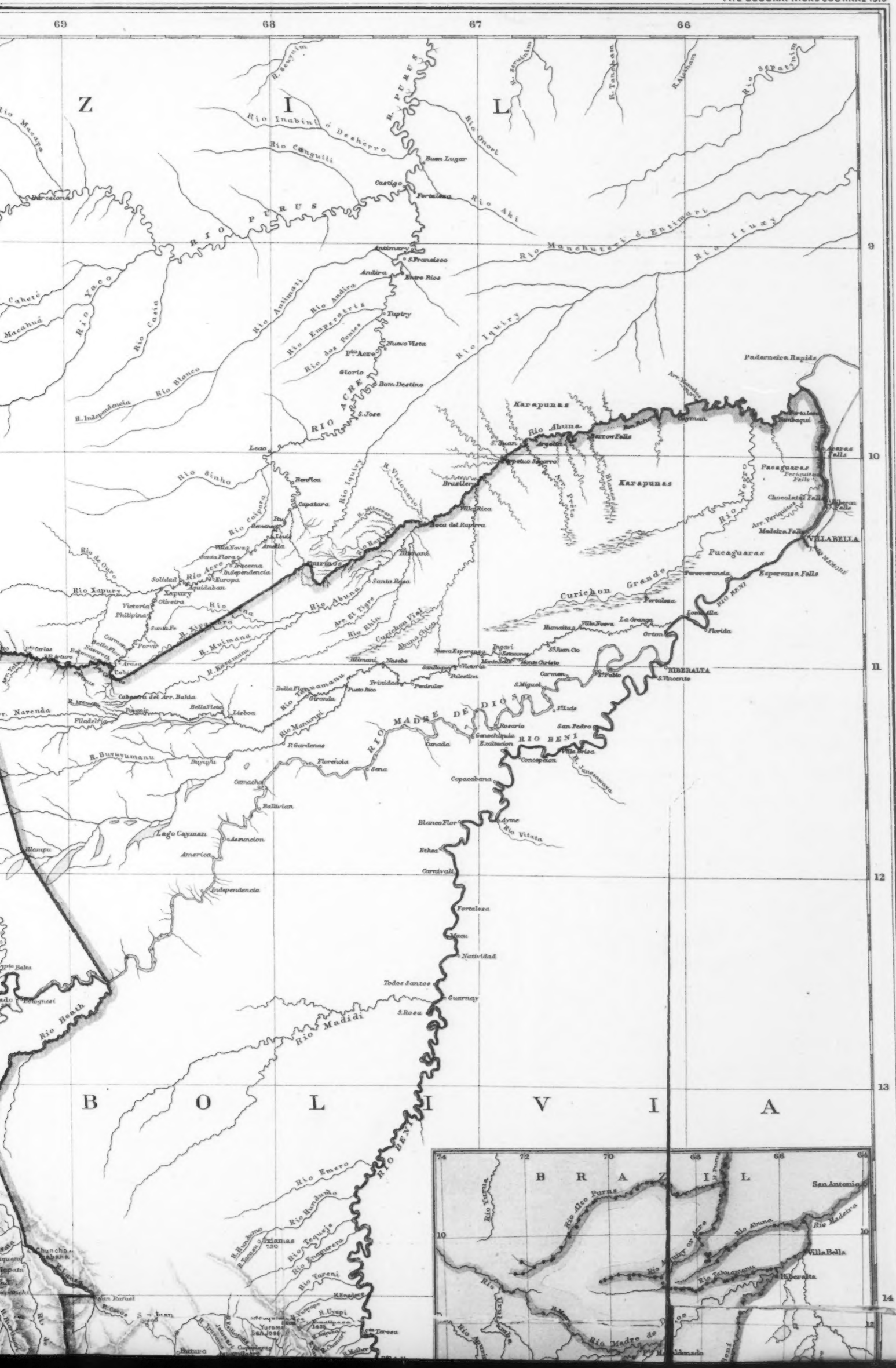
N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be aeknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.

SOUTH PERU AND NO

INCLUDING THE RUBBER YIE



ORTH BOLIVIA
YIELDING MONTAÑA


69
68
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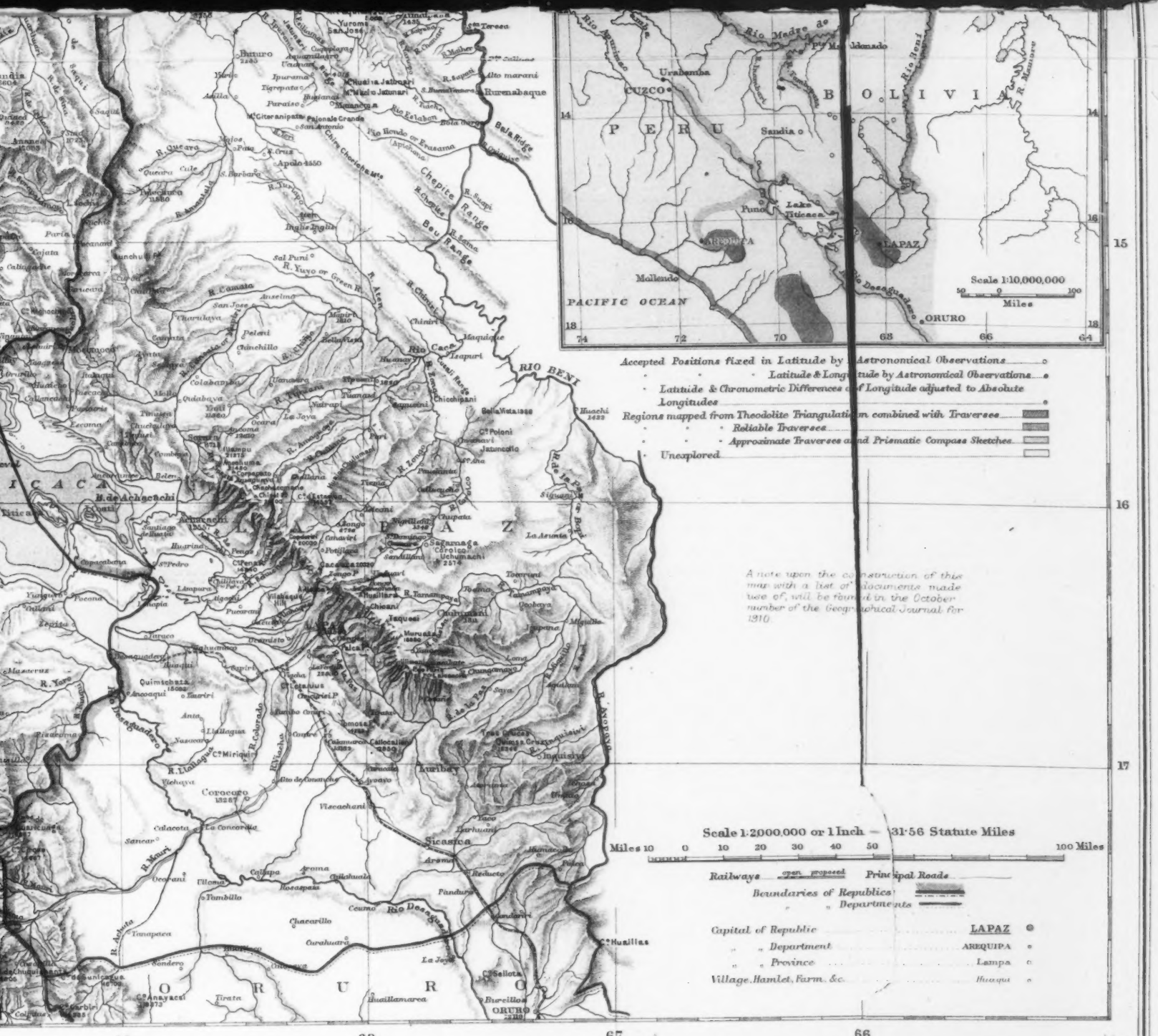
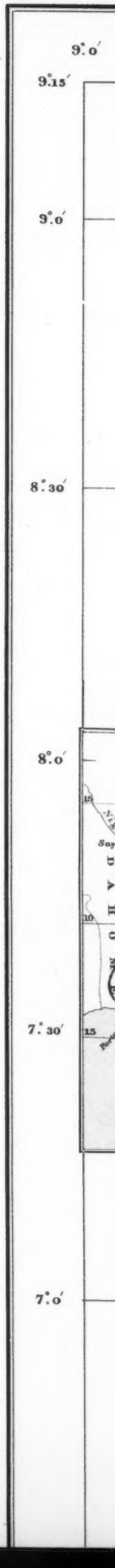
Z I L
B O L I V I A
B R A Z I L
R. Beuynim
R. Purus
Rio Inabini ó Desherro
Rio Onori
R. Tanaham
R. Alexiam
Rio Sepatyim
Rio Macapa
Barcelona
Rio Purus
Rio Cenguli
Buen Lugar
Castigo
Fortaleza
Rio Aki
Rio Manchuteri ó Eninari
Rio Ituxy
Antimary
S. Francisco
Andira
Entre Rios
Rio Andira
Rio Antimari
Rio Yaco
Rio Caeté
Rio Caeia
Rio Blanco
Rio Empecatriz
Rio dos Pontes
Tapiry
Pto Acre
Nuevo Vista
Glorio
Bom Destino
S. Jose
R. Independencia
Rio Iquiry
Leao
Rio Sinho
Rio Caipora
Rio Acre
Rio Abuna
Rio Negro
Rio Madeira
Rio Purus
Rio Iquiry
Rio Javary
Rio Yurua
Rio Alto Purus
Rio Tahuamanu
Rio Manuripi
Rio Madre de Dios
Rio Beni
Rio Heath
Rio Madidi
Rio Emero
Rio Hondumo
Rio Tequeje
Rio Enquiquere
Rio Tarene
Rio Mamore
Rio Itenez
Rio Guapore
Rio Paraguay
Rio Xapury
Rio Mainana
Rio Rapenama
Rio Arenda
Rio Buyuyumanu
Rio Negro
Rio Vitata
Rio Javary
Rio Yurua
Rio Alto Purus
Rio Abuna
Rio Madeira
Rio Tahuamanu
Rio Beni
Rio Mamore
Rio Itenez
Rio Guapore
Rio Paraguay
Rio Negro
Rio Vitata
Rio Madre de Dios
Rio Manuripi

PERU
AREQUIPA
MOQUEGUA
PUNO
CHILE
LAKE TITICACA
12508 ft. Above sea level
PACIFIC OCEAN
PAMPA DE ISLAY
PAMPA DE CLEMESI
Río Tambo
Río de Moquegua
Río Locumba
Río Sama
Río Chili
Río de Vitor
Río de Majes
Río de Camaná
Río de Ocoña
Río Apurimac
Río Pampas
Río Mantaro
Río Urubamba
Río Ucayali
Río Vilcanota
Río Desaguadero
Río Ilave
Río Huancané
Río Coata
Río Suches
Río Maure
Río Mauri
Río Tacna
Río Caplina
Río Uchusuma
Río Salado
Río Callazas
Río Sihuas
Río Siguas
Río Yauca
Río Acari
Río Grande
Río Ocoña
Río Camaná
Río Majes
Río Vitor
Río Chili
Río Tambo
Río Moquegua
Río Locumba
Río Sama
Río Caplina
Río Ilave
Río Huancané
Río Coata
Río Suches
Río Maure
Río Mauri
Río Tacna
Río Desaguadero
Río Vilcanota
Río Urubamba
Río Ucayali
Río Mantaro
Río Pampas
Río Apurimac


Rio Madre de
Urubamba
CUZCO
P E R U
Sandia
Lake Titicaca
Puno
AREQUIPA
Mollendo
PACIFIC OCEAN
B O L I V I A
LAPAZ
ORURO
Scale 1:10,000,000
50 0 100
Miles
74
72
70
68
66
64
18
16
14
15
Accepted Positions fixed in Latitude by Astronomical Observations
Latitude & Longitude by Astronomical Observations
Latitude & Chronometric Differences of Longitude adjusted to Absolute Longitudes
Regions mapped from Theodolite Triangulation combined with Traverses
Reliable Traverses
Approximate Traverses and Prismatic Compass Sketches
Unexplored
A note upon the construction of this map with a list of documents made use of, will be found in the October number of the Geographical Journal for 1910.
Scale 1:2,000,000 or 1 Inch = 31·56 Statute Miles
Miles 10 0 10 20 30 40 50 100 Miles
Railways open proposed
Principal Roads
Boundaries of Republics
Departments
Capital of Republic LAPAZ
Department AREQUIPA
Province Lampa
Village, Hamlet, Farm, &c. Huaqui
RIO BENI
RIO DESAGUADERO
Rio Beni
Rio Mamoré
Rio Grande
Rio Desaguadero
Rio Madre de Dios
Rio Manuripi
Rio Tambopata
Rio Inambari
Rio Heath
Rio Abuna
Rio Orton
Rio Tahuamanu
Rio Acre
Rio Purus
Rio Yaco
Rio Javary
Rio Ucayali
Rio Urubamba
Rio Apurimac
Rio Pachachaca
Rio Pampas
Rio Mantaro
Rio Huallaga
Rio Marañon
Rio Huancabamba
Rio Chinchipe
Rio Santiago
Rio Morona
Rio Pastaza
Rio Tigre
Rio Napo
Rio Putumayo
Rio Yapura
Rio Negro
Rio Uaupes
Rio Branco
Rio Caqueta
Rio Guaviare
Rio Meta
Rio Orinoco
Rio Arauca
Rio Casanare
Rio Pauto
Rio Cravo
Rio Sucio
Rio Magdalena
Rio Cauca
Rio Patia
Rio Mira
Rio Guayas
Rio Daule
Rio Babahoyo
Rio Vinces
Rio Zarumilla
Rio Tumbes
Rio Chira
Rio Piura
Rio Huancabamba
Rio Quiroz
Rio Jequetepeque
Rio Chicama
Rio Moche
Rio Viru
Rio Santa
Rio Lacramarca
Rio Nepeña
Rio Casma
Rio Huarmey
Rio Fortaleza
Rio Pativilca
Rio Supe
Rio Huaura
Rio Chancay
Rio Rimac
Rio Lurin
Rio Mala
Rio Omas
Rio Cañete
Rio Chincha
Rio Pisco
Rio Ica
Rio Grande de Nazca
Rio Acari
Rio Yauca
Rio Ocoña
Rio Camana
Rio Quilca
Rio Vitor
Rio Chili
Rio Tambo
Rio Moquegua
Rio Locumba
Rio Sama
Rio Caplina
Rio Loa
Rio Salado
Rio Toconce
Rio Grande
Rio Lauca
Rio Desaguadero
Rio Mauri
Rio Coata
Rio Ramis
Rio Huancané
Rio Suches
Rio Tambillo
Rio Colorado
Rio Llallagua
Rio Yuracaré
Rio Chapare
Rio Ichilo
Rio Mamoré
Rio Grande
Rio Pilcomayo
Rio Paraguay
Rio Bermejo
Rio Pilaya
Rio Pilcomayo
Rio Tarija
Rio Grande de Tarija
Rio Pilaya
Rio Parapeti
Rio Grande
Rio Pilcomayo
Rio Paraguay
Rio Bermejo
Rio Salado
Rio Dulce
Rio Juramento
Rio Pasaje
Rio Urubamba
Rio Apurimac
Rio Pachachaca
Rio Pampas
Rio Mantaro
Rio Huallaga
Rio Marañon
Rio Huancabamba
Rio Chinchipe
Rio Santiago
Rio Morona
Rio Pastaza
Rio Tigre
Rio Napo
Rio Putumayo
Rio Yapura
Rio Negro
Rio Uaupes
Rio Branco
Rio Caqueta
Rio Guaviare
Rio Meta
Rio Orinoco
Rio Arauca
Rio Casanare
Rio Pauto
Rio Cravo
Rio Sucio
Rio Magdalena
Rio Cauca
Rio Patia
Rio Mira
Rio Guayas
Rio Daule
Rio Babahoyo
Rio Vinces
Rio Zarumilla
Rio Tumbes
Rio Chira
Rio Piura
Rio Huancabamba
Rio Quiroz
Rio Jequetepeque
Rio Chicama
Rio Moche
Rio Viru
Rio Santa
Rio Lacramarca
Rio Nepeña
Rio Casma
Rio Huarmey
Rio Fortaleza
Rio Pativilca
Rio Supe
Rio Huaura
Rio Chancay
Rio Rimac
Rio Lurin
Rio Mala
Rio Omas
Rio Cañete
Rio Chincha
Rio Pisco
Rio Ica
Rio Grande de Nazca
Rio Acari
Rio Yauca
Rio Ocoña
Rio Camana
Rio Quilca
Rio Vitor
Rio Chili
Rio Tambo
Rio Moquegua
Rio Locumba
Rio Sama
Rio Caplina
Rio Loa
Rio Salado
Rio Toconce
Rio Grande
Rio Lauca
Rio Desaguadero
Rio Mauri
Rio Coata
Rio Ramis
Rio Huancané
Rio Suches
Rio Tambillo
Rio Colorado
Rio Llallagua
Rio Yuracaré
Rio Chapare
Rio Ichilo
Rio Mamoré
Rio Grande
Rio Pilcomayo
Rio Paraguay
Rio Bermejo
Rio Pilaya

TRIGONOMETRICAL STATIONS.

Place.	Trig. Points.	Latitude N.			Longitude E.			Height in feet above Sea Level.
		°	′	″	°	′	″	
Yola, Centre	—	9	12	30	12	29	29	—
Uom	A	8	57	15·84	12	23	40·78	2468
Gijaro	B	8	58	58·79	12	11	27·7	2281
Bayare	C	8	54	37·04	12	10	31·75	1476
Garum	D	9	04	50·56	12	8	49·1	1332
Lamja	E	8	51	04·54	11	56	52·71	3508
Nakussi	F	8	48	25·16	12	01	17·01	1885
Mungla	G	8	38	44·94	11	59	49·92	4487
Sivi	H	8	41	06·02	11	48	51·21	3633
Dakka	K	8	33	15·66	11	47	44·61	5338
Yagun	L	8	37	25·315	11	45	22·20	5033
Vorsen Peak	M	8	30	00·64	11	43	24·77	4273
Gankita	N	8	28	53·42	11	45	08·97	2578
Bashi	P	8	27	34·52	11	43	15·81	2141
Nashi	Q	8	28	58·47	11	42	43·6	2428
One Tree Hill	R	8	27	23·09	11	41	19·7	1809
Gangirra	S	8	27	47·19	11	40	30·66	1909
Gamamisa	U	8	26	55·035	11	40	43·817	1809
Gantini	T	8	27	25·18	11	39	04·79	1814
Spur End	V	8	24	19·13	11	39	20·23	1802
Limit Hump	W	8	25	24·4	11	37	18·67	1680
Denaba	Y	8	24	58·33	11	35	22·555	1995
Gani	X	8	23	34·93	11	36	19·75	1703
Kukederi	Z	8	21	55·73	11	33	02·89	2230
Middle Hill	Ya	8	24	33·37	11	32	36·97	2086
Yunkussum	A_1	8	23	48·21	11	27	09·545	2085
Ganyi	B_1	8	21	03·07	11	26	23·355	1620
Pabani	C_1	8	22	01·99	11	23	21·54	1551
Dumbarri Ridge	D_1	8	19	24·60	11	22	04·41	2706
Kwonkussum	E_1	8	23	13·305	11	20	36·755	2373
End Dumbarri Spur	F_1	8	19	01·12	11	20	34·92	2102
Kam Hill	G_1	8	17	11·18	11	16	53·02	1268
Cloven Hill	H_1	8	14	04·625	11	20	43·695	1518
	J_1	8	13	34·58	11	16	01·231	1520
	K_1	8	9	28·785	11	16	58·275	—
	L_1	8	8	55·267	11	13	31·489	1717
Idim Hill	M_1	8	9	29·781	11	10	51·646	1892
	N_1	8	4	03·458	11	10	21·92	1117
	O_1	8	6	09·51	11	13	31·221	1373
Pabun	P_1	8	1	13·993	11	10	45·02	1700
	Q_1	8	3	36·64	11	5	28·984	942
Kunassim (Lake)	R_1	7	58	56·94	11	4	54·898	1610
Maifula	S_1	7	59	54·733	10	59	54·281	1872
Twin Hill	T_1	7	54	24·598	11	02	53·663	1352
Kunju	U_1	7	50	34·565	10	57	37·256	1333
	V_1	7	53	31·357	10	56	06·424	785
Kunagyp	W_1	7	51	39·337	10	52	58·607	1230
Kalo	X_1	7	46	01·367	10	57	23·183	1698
Abakum	Y_1	7	44	08·70	10	54	01·436	1787
Gana	Z_1	7	46	36·496	10	49	45·533	2649
	A_2	7	49	36·453	10	47	48·426	1415
Gazabu	B_2	7	53	53·269	10	47	[illegible]	1066
Kungana	C_2	7	51	39·258	10	43	13·011	2190
Wuro Yato	D_2	7	53	36·394	10	39	53·492	2138
Solari	E_2	7	45	06·423	10	35	31·619	1248
Bush Pt.	F_2	7	46	42·575	10	28	30·818	722
Solari (High Pt.)	G_2	7	43	40·286	10	36	00·619	2790
	H_2	7	39	48·888	10	32	02·892	2651
Erima	J_2	7	38	57·581	10	28	59·394	2656
	K_2	7	36	08·592	10	30	49·720	2491
	L_2	7	33	34·368	10	33	34·752	1597
	M_2	7	31	44·929	10	31	47·182	1452
	N_2	7	29	55·717	10	34	06·314	1620
Oodi	O_2	7	24	00·200	10	30	58·339	1332
	P_2	7	29	06·086	10	28	51·795	1065
Yato Kura	Q_2	7	21	02·678	10	24	49·971	1908
	R_2	7	15	27·692	10	25	04·059	1384
Gargai	S_2	7	12	20·055	10	19	40·066	3190
Nydo	T_2	7	14	53·187	10	14	08·978	1345
Kunabai	U_2	7	10	03·005	10	04	17·236	2350
Pambo	V_2	7	02	44·805	10	04	34·205	2051
Kuroko	W_2	7	0	02·434	10	00	36·476	2899
Lissa	X_2	6	55	25·440	10	3	59·885	2740
	Y_2	6	58	27·968	9	58	47·426	3795
Lutu	Z_2	6	55	33·385	10	00	42·431	3257
	A_3	6	52	41·877	9	55	24·398	3431
	B_3	6	51	33·353	9	59	11·857	3923
	E_3	6	50	51·1	9	53	24·800	893
	C_3	6	48	42·046	9	54	26·527	1627
	D_3	6	50	12·370	9	52	11·791	2144
	G_3	6	46	02·915	9	52	12·095	1278
	H_3	6	43	03·854	9	54	15·632	2105
	I_3	6	44	02·786	9	51	17·556	2141
	J_3	6	43	35·797	9	48	55·178	2466
	K_3	6	41	17·054	9	47	52·522	3030
Umbay	L_3	6	43	00·369	9	45	04·241	1513
Enegbi	M_3	6	39	11·091	9	44	08·898	2804
	N_3	6	39	28·383	9	46	32·563	2107
	O_3	6	35	20·766	9	42	57·073	3186
Buffalo Beacon	P_3	6	32	56·544	9	44	18·842	3750
Maquari River	Q_3	6	29	41·486	9	42	34·246	1272
Tunga River	R_3	6	31	13·497	9	34	54·891	2490
	S_3	6	27	35·930	9	39	31·504	1790
Ituava	T_3	6	26	35·246	9	31	07·184	2341
Atanga	U_3	6	30	23·633	9	27	27·190	3481
Watershed (S.)	V_3	6	20	49·961	9	24	22·508	5392
Watershed (N.)	W_3	6	24	41·317	9	22	19·806	5577
	X_3	6	23	31·942	9	20	53·303	—
Abayon	Y_3	6	18	00·00	9	18	00·00	1654



9°30′ 10°0′ 10°30′

NIGERIA – CAMEROONS BOUNDARY COMMISSION SURVEY

YOLA - CROSS RIVER.

(Reduced from Boundary Commission Map).

1907 – 09.

Scale 1: 1,000,000 or 1 Inch = 15·78 Stat. Miles.

Miles 10 5 0 10 20 30 40 50 Miles

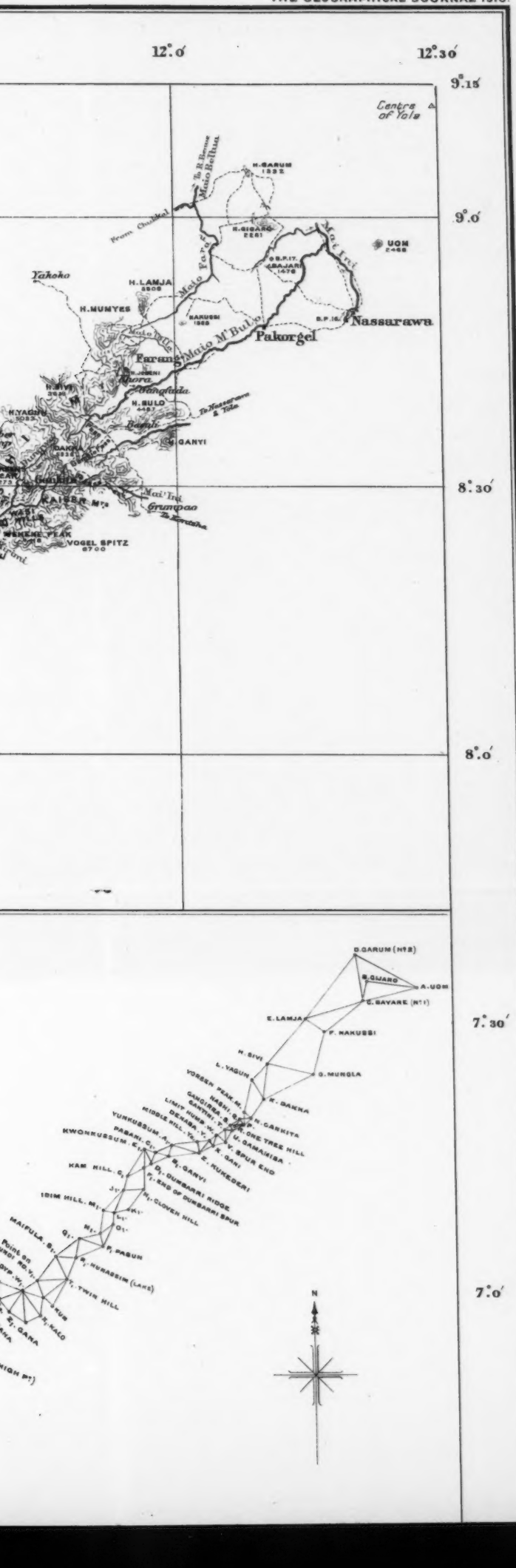
Kilometres 10 5 0 10 20 30 40 50 Kilometres

* IBI

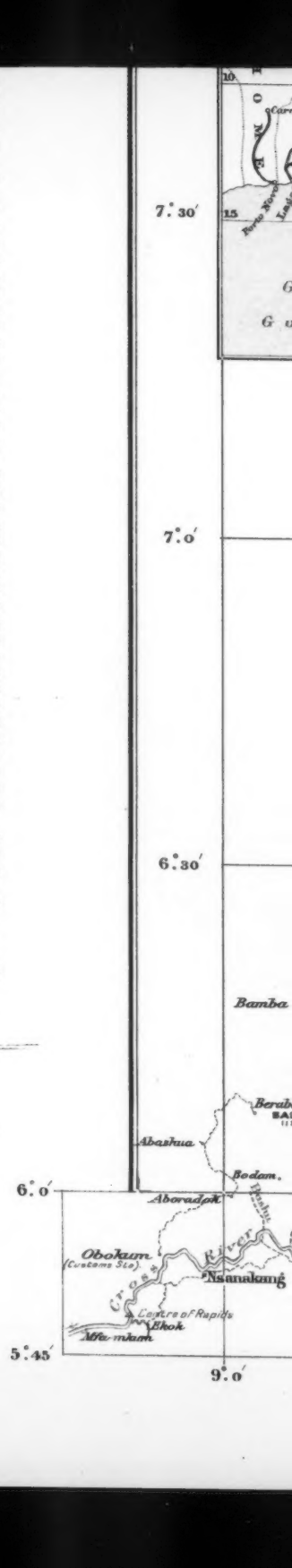
Takum
Jato
Kasimbila
Joruba Munshis
Gei (Maitumbi's Country)
Toso
Didon
Gamba
Yola
Bakundi
Gidan Sama
Gidan Gargai
Mumbai
Madaha
Lissam
Kukono
Mt Sumbi
Mt Gamana
Mt Kombon
Mt Kwaya
Mt Kwanga
Mt Kwanga
Mt Kwanga

11°.30′
11°.0′
11°.30′
KAM HILLS
PROMINENT JAGGED PINNACLE OF ROCK
BUNAKUSSUM
ROCKY SPIKE AT RANGE END
H.KWONKUSSUM 5372
H.GARVI 1620
H.SHINA
H.BATACHA 1268
H.IDIM 1892
H.KADURI 1872
H.GUMBA
H.TUKORUA
H.SHEKUSSUM
KUNASSIM 1810
H.VULGANI
H.SAMOI
H.GAZABU
H.BAKUNDI
Bakundi
Daguma
Maiduria
Beli
860
H.KUN (BELI PEAK) 4874
H.SALO
KATAU
Gongama Forest
Gongame
Dense Bush
Tree covered plateau with deep ravines & numerous watercourses.
Impracticable country rocky valleys and impassable ravines.
Large boulders prominent landmarks
Vukka
Gamba
FALI MTS
Didon
Soiya
Abaradirschir
M. Kam
M. Wurkam
M. Lumen
M. Terraba
W. Garkwar
W. Sambo.
W. Abalaka
Prem. Jabeng
Rubber camp
GANTENG
Tagkarasiye
KUNTIBERI
ONE TREE HILL
PUMBAKAH
H. SAGJI
TEKUSSUM
PEAKED HILL
H. DUMPAR
H. PABUN
DUTSIN KUNGANA
H. AARUN
Kungana (Fulani)
M. Gajami
M. Kunsu
M. Gazabu
M. Kun
M. Gongame
M. Vukka
M. Gamba
M. Didon
M. Soiya
M. Abaradirschir
MAIDUGURI
Point on BELI - BAMBORO RD.
KUNASSIM - W.
GAZABU - G2.
WURO YATO - D2.
SOLARI - E2.
BUSH PT. F2.
G2. KUBANIA
G2. SOLARI (HIGH PT.)
ERIMA - J2.
YATO KURA - Q2.
HYDO - T2.
KUHABAI - U2.
S2. GARGAI
KUROKO - W2.
V2. PAMBO (MAIDAIKI)

NIGERIA-CAMEROONS BOUNDARY.



Kungana	C_2 ..	7	51	39·258	10	43	13·011	2190
Wuro Yato	D_2 ..	7	53	36·394	10	39	53·492	2138
Solari	E_2 ..	7	45	06·423	10	35	31·619	1248
Bush Pt.	F_2 ..	7	46	42·575	10	28	30·818	722
Solari (High Pt.)	G_2 ..	7	43	40·286	10	36	00·619	2790
.....	H_2 ..	7	39	48·888	10	32	02·892	2651
Erima	J_2 ..	7	38	57·581	10	28	59·394	2656
.....	K_2 ..	7	36	08·592	10	30	49·720	2491
.....	L_2 ..	7	33	34·368	10	33	34·752	1597
.....	M_2 ..	7	31	44·929	10	31	47·182	1452
.....	N_2 ..	7	29	55·717	10	34	06·314	1620
Oodi	O_2 ..	7	24	00·200	10	30	58·339	1332
.....	P_2 ..	7	29	06·086	10	28	51·795	1065
Yato Kura	Q_2 ..	7	21	02·678	10	24	49·971	1908
.....	R_2 ..	7	15	27·692	10	25	04·059	1384
Gargai	S_2 ..	7	12	20·055	10	19	40·066	3190
Nydo	T_2 ..	7	14	53·187	10	14	08·978	1345
Kunabai	U_2 ..	7	10	03·005	10	04	17·236	2350
Pambo	V_2 ..	7	02	44·805	10	04	34·205	2051
Kuroko	W_2 ..	7	0	02·434	10	00	36·476	2899
Lissa	X_2 ..	6	55	25·440	10	3	59·885	2740
.....	Y_2 ..	6	58	27·968	9	58	47·426	3795
Lutu	Z_2 ..	6	55	33·385	10	00	42·431	3257
. .....	A_3 ..	6	52	41·877	9	55	24·398	3431
.....	B_3 ..	6	51	33·353	9	59	11·857	3923
.....	E_3 ..	6	50	51·1	9	53	24·800	893
.....	C_3 ..	6	48	42·046	9	54	26·527	1627
.....	D_3 ..	6	50	12·370	9	52	11·791	2144
.....	G_3 ..	6	46	02·915	9	52	12·095	1278
.....	H_3 ..	6	43	03·854	9	54	15·632	2105
.....	I_3 ..	6	44	02·786	9	51	17·556	2141
.....	J_3 ..	6	43	35·797	9	48	55·178	2466
.....	K_3 ..	6	41	17·054	9	47	52·522	3030
Umbay	L_3 ..	6	43	00·369	9	45	04·241	1513
Enegbi	M_3 ..	6	39	11·091	9	44	08·898	2804
.....	N_3 ..	6	39	28·383	9	46	32·563	2107
.....	O_3 ..	6	35	20·766	9	42	57·073	3186
Buffalo Beacon	P_3 ..	6	32	56·544	9	44	18·842	3750
Maquari River	Q_3 ..	6	29	41·486	9	42	34·246	1272
Tunga River	R_3 ..	6	31	13·497	9	34	54·891	2490
.....	S_3 ..	6	27	35·930	9	39	31·504	1790
Ituava	T_3 ..	6	26	35·246	9	31	07·184	2341
Atanga	U_3 ..	6	30	23·633	9	27	27·190	3481
Watershed (S.)	V_3 ..	6	20	49·961	9	24	22·508	5392
Watershed (N.)	W_3 ..	6	24	41·317	9	22	19·806	5577
.....	X_3 ..	6	23	31·942	9	20	53·303	—
Akongo	Y_3 ..	6	18	39·430	9	11	25·734	1672
.....	Y_{3a} ..	6	18	13·292	9	11	24·820	1737
Bashu	Z_3 ..	6	6	38·923	9	9	27·275	1123
.....	A_4 ..	6	5	56·051	9	10	16·516	—
*B.P. No. 7	B_4 ..	6	5	50·334	9	9	30·943	442
B.P. No. 7 *German values*	B_4 ..	6	5	49·964	9	9	28·723	—
.....	C_4 ..	6	5	20·148	9	8	56·713	—
.....	D_4 ..							—
B.P. No. 5	—	6	4	25·426	9	8	00·886	324
*Agreed mean for B.P. No. 7	B_4 ..	6	5	50·149	9	9	29·833	—



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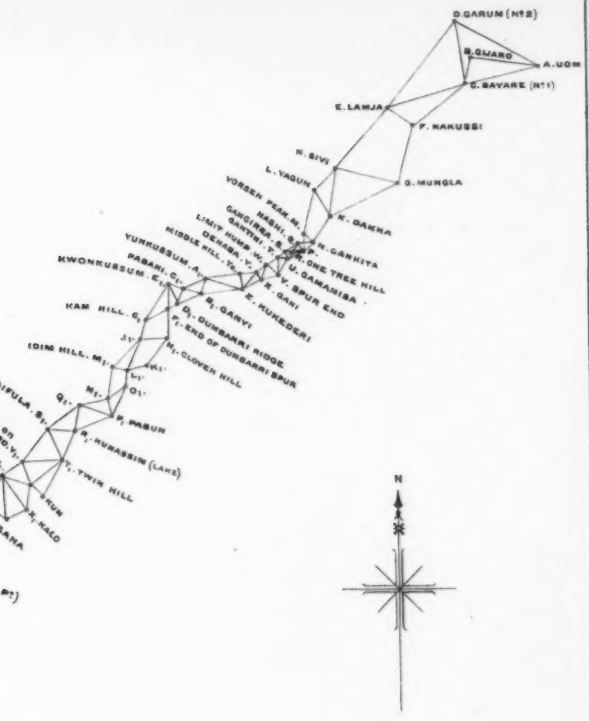


7°30′

7°0′

6°30′

GERIA-CAMEROONS BOUNDARY

CHART
Showing the
TRIANGULATION

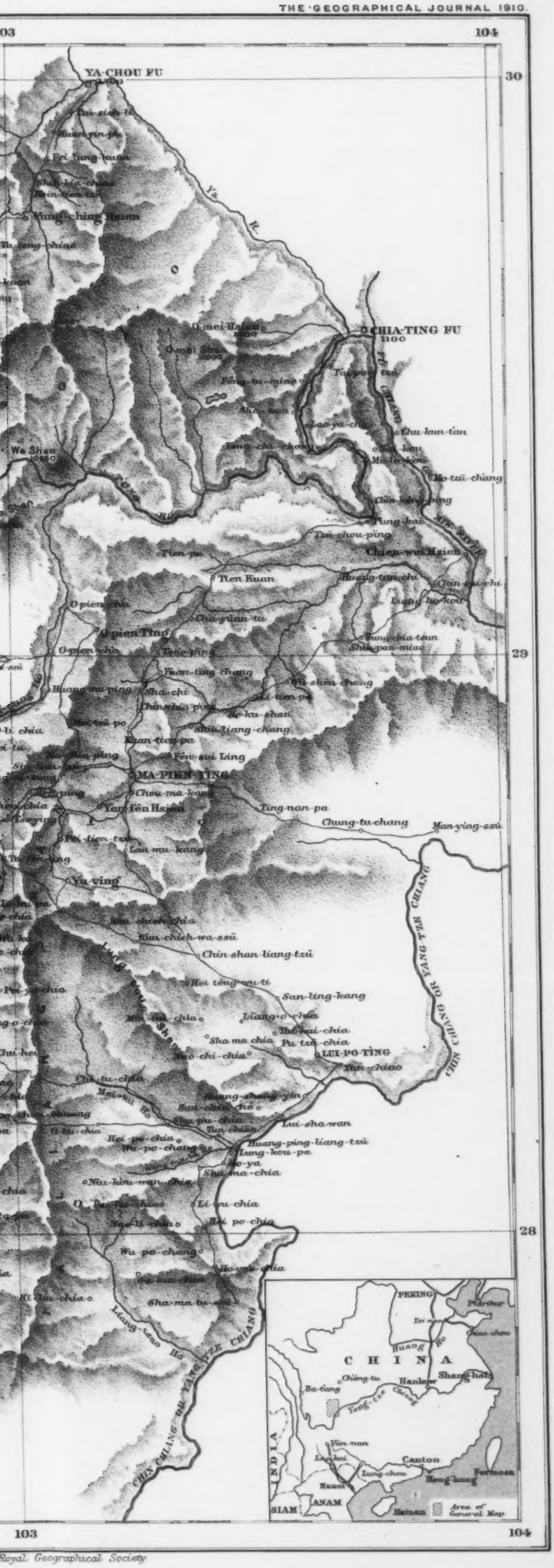
Scale 1: 2,000,000 or 1 Inch - 31·56 Stat. Miles.

10 0 10 20 30 40 50

6°0′

12°0′ 12°30′

102
103
30
29
28
CHINA.
Part of
SOUTHERN SE-CHUAN
(LOLOLAND)
from a
Plane-table Survey
and
Native Information
by
W. N. FERGUSSON.
Scale 1:1,000,000 or 1 inch = 15·78 Stat. Mls
Route
Heights in feet.
Chi-kung Shan
Tsé-kú Shan
YUEH-SHI-TING
Mien-ning Hsien
Ning-yuan Fu
Chin-chang
Tsai-tzŭ Shan
Ta-hsiang-ling-ping
Published by the Royal


103
104
30
29
28
YA-CHOU FU
1400
CHIA-TING FU
1100
We Shan
10850
Chien-wei Hsien
O-pien Ting
MA-PIEN TING
Yen Hsien
LUI-PO TING
Ya R.
Min R.
Tung R.
Fu R.
Chin-sha Kiang or Yang-tze Chiang
Liang-shao Ho
PEKING
Petrograd
CHINA
Hankow
Shang-hai
Canton
Formosa
INDIA
SIAM
ANAM
Hainan
Area of General Map